PROCEEDINGS

XIX INTERNATIONAL CONGRESS OF ENTOMOLOGY

ABSTRACTS

BEIJING, CHINA
JUNE 28–JULY 4, 1992

Living with Insects

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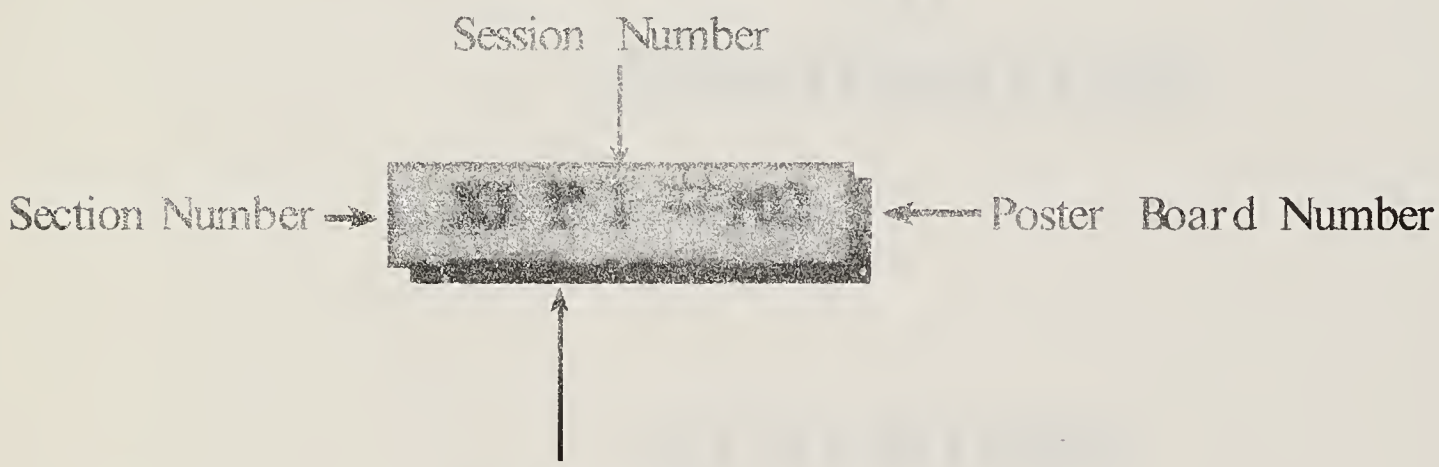
Editorial Notes

1. The majority of the abstracts in this book have not been edited by the Organizing Committee and are printed as received. A few abstracts were retyped because they were submitted in a form not suitable for publication or in an incorrect format.

2. The abstracts are arranged on pages in order of presentation within each session. The sequence of abstracts (a, b, c, d, e, f)for each page is shown to the right. It is accompanied by the page number in the index. Poster papers are numbered according to their poster board number within each session.

a	d
b	e
c	f

3. Key to session identification:



S = Symposium
G = Special Interest Group
W = Workshop
C = Contributed Paper
P = Poster
A = Abstract Only
PL = Plenary Lecture
ESL = Enlarged Sectional Lecture
M = Meeting

4. The speakers' names are underlined in the abstracts.

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OPENING AND CLOSING LECTURES

OPENING LECTURE

PRINCIPLES AND IMPLEMENTATION OF INTEGRATED PEST MANAGEMENT IN CHINA. **Da-rong Zhou, Zhi-xin Tao** (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China), **Dian-mo Li** (Institute of Zoology, Chinese Academy of Sciences, Beijing 100080, China), **Qi-hua Yang** (Beijing Agricultural University, Beijing 100094, China) & **Zhao-hui Zeng** (General Station of Plant Protection, Ministry of Agriculture, Beijing 100026, China)

The earliest Chinese literature clearly concerning insect pest control was found in Zhou Dynasty, about 3,000 years ago. Simple and primitive ideas/concepts of IPM can be traced back to as early as several hundred years ago, especially in controlling the oriental migratory locust ***Locusta migratoria manilensis*** (Meyen) —the most important and disastrous insect pest in Chinese history. The first full-time officer for locust control was appointed by the Emperor of Tang Dynasty (*ca.* 1,270 years ago), and from then on to the year 1911, 538 serious outbreaks of the locust were recorded.

This paper presents a brief overview of the development of IPM concept and principles in China during the period of 1949-1982, cites a successful example of locust IPM in China up to 1958, with focus on IPM research and implementation within the period of 1983-1991. A major research program at the national level entitled "Research Program on IPM of Main Plant Diseases and Insect Pests on Agricultural Crops" had been carried out during this period. The program was directly supervised and financially supported by four important government agencies, *viz.* the State Planning Commission, State Economic Commission, State science & Technology Commission and the Ministry of Agriculture. The target pests included some most important species such as the paddy stem borer ***Tryporyza incertulas***, rice stem borer ***Chilo suppressalis***, brown planthopper ***Nilaparvata lugens***, and the rice case worm ***Cnaphalocrocis medinalis*** etc. on rice; the oriental army worm ***Mythimna separata***, wheat blossom midge ***Sitodiplosis mosellana*** and the wheat aphid ***Macrosiphum granarium***, *etc.* on wheat; the Asian corn borer ***Ostrinia furnacalis*** on Maize; and the cotton aphid ***Aphis gossypii***, cotton bollworm ***Heliothis armigera***, cotton red spider ***Tetranychus telarius***, *etc.* on cotton. About 1,000 scientific workers, including entomologists, phyto-pathologists and breeders were incorporated in the Program. This paper roughly categorizes the 10-year research and implementation activities into: (1) basic aspects of applied research including biology and behavioural studies, (2) key IPM component research and (3) extension of the IPM system and large-scale demonstration. major achievements and representative successful cases were introduced. Defects at present and prospects in the future of IPM research and implementation in China are also evaluated and discussed.

CLOSING LECTURE

DEVELOPMENTAL REGULATION OF GENE EXPRESSION IN INSECTS; BASIC MECHANISMS AND POTENTIAL APPLICATIONS. **Fotis C. Kafatos** (Harvard University, Biological Laboratories, 16 Divinity Avenue Cambridge, MA 02138, USA)

Development entails the programmed regulation of gene activity over time and in specific cells of the organism. This programming begins with establishment of asymmetries in the body, anterior to posterior and dorsal to ventral. The program is then elaborated through cellular interactions, and cells become committed to specific paths of differentiation, defined by the activity of corresponding sets of genes. The differentiation process frequently is sequential, i.e. specific subsets of genes may be turned on and off over time in a single cell or cell lineage. In organisms which undergo metamorphosis, such as insects, this temporal succession is very prominent and is punctuated by hormonal switches. The differentiation process is also highly detailed in space, so that cells of the same general differentiation type but different locations may be distinguishable in terms of the activity of specific genes.

While this conceptual framework of development is old, it has been made concrete in recent years, largely as a result of the recombinant DNA revolution. Insects have played a key role in this progress. In particular, *Drosophila melanogaster* has paved the way to our understanding of developmental programming in gene activity, because of its unique combination of experimental resources; the relatively simple body plan, the sophisticated genetics, the polygene chromosomes, and the existence of an efficient germ-line transformation procedure which permits *in vivo* testing of the activity of *in vitro* engineered genes. Many Drosophila regulatory genes have now been defined, both genetically and molecularly. Their hierarchical interactions across the asymmetric egg can explain the progressive elaboration of the spatial and temporal developmental program in the embryo. For specific cell differentiation programs, DNA elements that control the activity of adjacent genes have been defined by transformation, and the regulatory genes encoding proteins that interact with these DNA elements have been characterized. Specific examples will be discussed.

Despite the great variety of insects, the evolutionary conservativeness of gene regulatory mechanisms ensures that the insights obtained in Drosophila can contribute to our understanding of developmental mechanisms in other insects. Regulatory genes of other insects can be cloned by virtue of their homology with known Drosophila components. At least in some cases, the DNA elements that regulate the activity of adjacent genes can be defined by transformation across species lines, in Drosophila. However, the multiplicative effects of accumulating knowledge in any one system argue that the depth of our understanding of developmental mechanisms in other insects will be greatly enhanced by concentrating on a very small number of carefully selected species. Development of efficient transformation procedures is an essential prerequisite for rapid progress.

The potential for applying our knowledge of developmental and gene regulatory mechanisms to insects of importance to humans is disrupting the populations or limiting the damage of target species, once transformation technology is in place and sufficient information on pertinent gene regulatory mechanisms has been accumulated. Examples of such strategies will be discussed. The dichotomy between basic and applied entomology is becoming blurred, as our knowledge expands in a focused manner, and as information is freely exchanged.

PLENARY LECTURES

PL1

LIVING WITH INSECTS. M.J. Whitten (CSIRO Division of Entomology, P.O. Box 1700, Canberra 2600, Australia)

In 1990, the national Organising Committee in selecting a theme for the XIXth International Congress, noted that entomologists studied insects from a variety of perspectives. Accordingly, the reasons why entomologists from around the world convened every four years were equally varied. In line with this, an appropriate theme needs to acknowledge the pluralistic nature of entomological endeavour, and the diverse interests of Congress participants; hence the chosen theme '**Living with Insects**'.

There is little doubt that the tendency for insects to compete with mankind for food and fibre, or even to have the temerity to use us as hosts or transmit disease to us and our livestock, is the primary reason why public funds are given to entomologists to pursue their life's love. Foremost then, entomological research reflects the economic impact that insects have on modern society, either as pests or beneficials. Not surprisingly, many sections of this Congress have an eye to applied entomological issues.

Other important associations between insects and mankind include their cultural and enviromental significance. During its long history, China in particular has recognised the cultural value of its insect fauna. Indeed, insects feature prominently in th cultural heritage of many societies in the east and west. Of more recent, and perhaps greater significance, has been the acceptance of the central role of insects in biological diversity, and its relevance to conservation and sustainable agriculture. In fact, China in the 1970's was the first country world wide to promote as government policy the goal of reducing dependence on chemical pesticides, promoting in its place integrated pest management and the use of indigenous natural enemies. This is the first Congress to devote a Section to biological conservation and diversity, even though entomologists have long understood the importance of these issues. This topic is likely to assume greater prominence in future Congresses.

Finally, the role of insects as models for research on fundamental issues such as development and neurobiology, behaviour and learning, evolution, ecology and speciation has advanced enormously over the past two decades. As research probes deeper, the similarity of fundamental processes becomes more apparent and so insects as more convenient tools become more important in resolving key basic issues in biology. Increasingly, processes and phenomena of central interest to human biology have found their precursors or counterparts in insects. Some of the most exciting developments discussed during this Congress will emerge from the study of insects as general model systems.

International Congresses of Entomology represent a unique opportunity for those concerned with the study of insects, whether in economic and applied entomology, environmental studies, or in the pursuit of basic knowledge, to enjoy the chance in closed chambers to discuss progress, exchange views or to gain a broad overview of disciplines further a field. However, it would be a mistake not to use such occasions to send some clear signals to key decision-makers who are responsible for the allocations of public funds that finance much of our research. It is up to us as entomologists to demonstrate that training future entomologists and funding their research represents a sound financial investment in the matrial, social and cultural well-being of today's people and the generations to come, both in urban and rural communities, and regardless of whether they live in the developed or developing world.

This Congress lecture will illustrate some of these ideas and suggest ways in which we can promote the value of '**living with insects**' once we return from the Congress to our respective homelands, so that entomology thrives both nationally and internationally.

PL2

THE EVOLUTION OF PESTICIDE USAGE AND PEST CONTROL, 1950-2000 AD. Trevor Lewis (AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ, UK)

The market for pesticide sales has risen rapidly since 1950 and now stands at $25,000M annually of which 30% is insecticides. Despite a tenfold increase in use of insecticides since 1950 crop losses due to insects have doubled. However, losses would be greater if pesticides were not used. As world population increases by 200,000 daily, food production must be safeguarded by ensuring that chemicals are used to maintain yields but with minimum risk to other forms of life and the environment. The perceived and real problems of insecticide use, including the development of resistance in insects will be reviewed.

There are now many effective ways of restricting pesticide use, particularly through monitoring and forecasting, and improved application. There are also exciting alternatives/supplements to conventional insecticides which are more easily integrated into pest management and sustainable agricultural systems. Several of these approaches, especially the use of semiochemicals, plant-derived anti-feedants and the genetic manipulation of plants will be described. Crop protection will become more sophisticated with reduced chemical but increased biological inputs. Companies concerned with crop protection may evolve into suppliers of high value chemicals, becoming corporate environmentalists, stewards of the products they produce and their disposal.

PL3

INSECTS IN THE CULTURAL LIFE OF CHINA. **Jun-de Qin** (Institute of Zoology, Academia Sinica, Beijing 100080, China)

China is rich in insect fauna, and many insect species have made important contribution to the cultural life of Chinese people. This article attempts to investigate their influence under following headings: 1. Chinese cultural attainments in relation to insect utilization and control, 2. insects in Chinese art and literature, and 3. insects in Chinese philosophy and religion.

1. Chinese cultural attainments through insect utilization and control are manifested in sericulture, in insectan materia medica and entomophagy, and in the control of locust and other insects. The impact of sericulture on Chinese culture may be observed in: (1) importance and contribution of feminine labour in sericulture which were extensively recorded in ancient literature and are still evident today; (2) silk dresses as conventional emblem in the ranking of social position; (3) silk fabrics used in taxation from farmers in ancient times and also as a means of commercial exchange; and (4) silk roads to remote countries for commerce leading to cultural communication. Locust outbreaks occurred frequently in Chinese history and posed a harassing social problem. Anti-locust campaigns were officially promoted early in Han and Tang Dynasties; the first imperial anti-locust decree was issued in Song Dynasty in 1075 and the second in 1182. The strategy of ecological reform of the locust originating centers for elimination of locust outbreak in new China coincides well with some of the ideas about locust outbreak in late Ming Dynasty.

2. Insects played an important role in Chinese art and literature. Great esthetical and artistic values were attached to their figure, color etc. in Chinese painting. The influence of insect on Chinese ideograph can be found in many ancient treatises on words and characters and in dictionaries. Insects were used to symbolize fertility, to signify feminine beauty and to serve as provocative to nostalgia in poetry and prose. They were personified in literature to reveal the writers' political and social views, and this tradition persisted in the works of modern writers including Lu Xun. Insect helped to enrich Chinese language with numerous idioms and expressions. They were also frequently depicted as themes in fables, myths and legends. The admirable traits of silkworm and honey bee were often cited in popular children's primers to educate youngsters. Crickets have been admired for their songs and rivalry fighting between male adults, and were used in some regions as gambling pets with demoralizing effect to the people.

3. In ancient Chinese philosophy, insects were interpreted in terms of the mystical doctrine of dualism (yin versus yang) and five elements (metal, wood, water, fire and earth). The outbreaks of insect pests were regarded as the result of the moral violation of the emperors; and the metaphysical idea of interaction between heaven and human morality hindered subsequent insect control. Other harmful philosophical ideas were the concepts of life transformation and spontaneous generation of insects. But there were also many counterviews based on actual observation. In Chinese religion, gods and goddesses of insects were worshiped rather inconsistently, and probably this tradition is inherited from Taoism.

In conclusion, insects have made great impact on the cultural life of Chinese people in various aspects and their influences persist to the present time in different regions of the country. However, insects were generally regarded as a lower group of life and inferior to the imaginary dragon, phoenix and "chielin" as totems for worship.

PLENARY LECTURES

PL4

FROM BEHAVIORAL ECOLOGY TO INTEGRATED PEST MANAGEMENT. Ronald J. Prokopy (Department of Entomology, University of Massachusetts, Amherst, MA, 01003, U.S.A.)

Behavioral ecology can be considered as the contribution of an organism's behavior to its survival and reproductive success within an evolutionary framework. Investigating the behavioral ecology of pest or beneficial insects can be of value not only to basic understanding of the evolution of life history traits but also to better methods of pest management.

Most insects require food, mates and egglaying sites as essential resources. Most insects use chemical and/or visual cues to find essential resources. Variation in the natural environment in which resources are located and in the insect's genetic, physiological and experiential state may have a profound effect on the manner in which an insect makes resourceforaging decisions and hence on the behavioral ecology of the insect.

My presentation will focus on tephritid frut flies, particularly apple maggot flies (*Rhagoletis pomonella*), as an illustration of how improved knowledge of insect behavioral ecology can lead to improved pest management practices. The nature of each type of fly essential resource will be described, followed by a brief analysis of the types of cues used by flies to find resources. Examples will be given of how variation in the state of the environment and the state of the fly can shape the resource--finding process and fly willingness to use a potential resource after it has been found. Results will be placed on development and use of odor/visual traps consisting of synthetic equivalents of natural resource stimuli. The traps can be used effectively for monitoring and directly controlling tephritids. Trap effectively for monitoring and directly controlling tephritids. Trap dfficacy may vary, however, according to the state of the environment and the state of the foraging fly. The conclusion will emphasize how long-term success of non-pesticidal behavioral approaches to pest manatement under a range of commercial crop conditions is intimately linked with an understanding of the behavioral ecology of the pest.

PL5

BIOLOGICAL CONTROL IN THE OCEANIC PACIFIC: AN OVERVIEW. **Dong F. Waterhouse** (Division of Entomology, Black Mountain, GPO Box 1700, Canberra ACT 2601, CSIRO Australia)

The Pacific, largest of all oceans contains some 25,000 islands, more than half the world's total. Many of them have always been isolated from each other and from the rest of the world by large expanses of water and, until the arrival of humans, animal and plant life was not at all diverse. The arrival of humans is comparatively, very recent: in Micronesia apparently not earlier than about 3000BC and in Polynesia about 1000BC. The early voyagers brought with them taro, breadfruit, yam, coconuts and bananas. In the last two centuries the diversity of introduced crops has increased enormously and so has the range of pests and diseases attacking all crops.

Because almost all of the food plants and pests are introduced, biological control of pests is highly appropriate for oceanic islands, particularly those with small human populations and extreme shortage of foreign exchange for purchasing pesticides. Indeed pest surveys in the south Pacific have shown that 85% or more of the major insect pests are introduced, particularly from Southeast Asia. Furthermore about 95% of the major weeds are introduced, most from Central or South America. In most instances these insect and weed pests are of much less importance in their area of origin because of attack by natural enemies. Classical biological control consists of introducing and establishing selected natural enemies when careful tests indicate that it is safe to do so.

Success rate in islands (Hawaii, in particular) or ecological islands (Australia, California) is the highest in the world, but has been very variable in most Pacific islands. For a decade after the late 1920's there was, however, a notable sequence of successes in Fiji, unmatched elsewhere in the South Pacific. Since then with a few notable exceptions (eg. with the rhinoceros beetle), results in the region have been mostly disappointing. It is thus very encouraging to report that, since the mid 1980's, a steadily growing and well supported momentum has been generated for biological control and this is already led to several significant successes, with more in prospect.

Nevertheless, the need for biological programs in the Pacific is likely to increase greatly in the future as air travel and tourists expand. In Hawaii, for example, an average of 3.5 pests per year become established and in Guam about 2.5 pests per year, most of these nowadays coming from the Americas.

Recent biological control successes include the white peach scale (*Pseudaulcaspis pentagona*) on passionfruit in Western Samoa; the banana skipper (*Erionota thrax*) and the floating fern (*Salvinia molesta*) in Papua New Guinea; and the spiralling whitefly (*Aleurodicus dispersus*) in many Pacific countries., These and other projects in progress will be illustrated.

PLENARY LECTURES

PL6

INSECT ECOLOGY: MAJOR DEVELOPMENT AFTER 1970 AND ITS RELATION TO APPLIED ENTOMOLOGY. **Yosiaki Ito** (Entomological laboratory, Nagoya University, Nagoya 464-01 Japan)

Four notable events, which took place during the last two decades, have created an era of dramatic changes in the study methods and principles of animal ecology; without full understanding of them, we will be unable to develop insect ecology and ecological methods of insect control.

The first of the four is the establishment of sociobiology (behavioural ecology), mainly based on principles of kin-selection, and evolutionarily stable strategy. This has not only created a tremendous increase in the number of studies of social behaviour of insects, including discovery of sterile soldiers in aphids and a parasitoid wasp, but also changed our views on population regulation. The ecologists could abandon their traditional, but non-scientific, view of selection acting on species or populations, and began to seek the way by which a genotype can leave the largest number of its copies. Thus, when population density is higher than the carrying capacity, females of a phytophagous lady beetle adopt one of two options, early reproduction and death or absorption of oocytes and extra hibernation for reproduction in the next season and Sawada, and the sugarcane chinch bug produces both macropterous and extremely brachypterous' progeny; the latter will consume recovered sugarcane stems after emigration of the former .

The second is a notable change of life history studies, based on optimal strategy models. This, in connection to the genotype fitness viewpoint mentioned above, has led to the important change in insect life history studies from simple description to quantitative and evolutionary analysis.

The third is the heated debates stimulated by recent criticisms against views on the prime importance of competition in commuity organization. Strong et al argued that interspecies competition is not important in community organization of phytophagous insects. Whether this is true, and whether the role of interspecies competition is different in phytophagous and carnivorous insects, are important questions for establishing our strategy of natural enemy introductions and pest eradication projects.

The fourth is the development of quantitative genetics, especially by the Chicago School. Quantitative genetics has been recently used to measure the intensity of natural selection in field conditions and evaluate relative roles of different selection episodes. However, this principle may be helpful for the analysis of insecticide resistance or colonization of insects on resistant crops.

I will explain these topics and their influence on insect ecology, using some examples of recent studies, and will stress that, as Ito and Kiritani wrote, "the most basic researches might be most profitable for insect control in the future."

PL7

ENDOCRINE REGULATION OF INSECT METAMORPHOSIS--A CHANGING WORLD VIEW. Lynn M. Riddiford, Department of Zoology, University of Washington, Seattle, WA 98195, USA.

Molting and metamorphosis of insects are basically controlled by two hormones--ecdysone which activates and coordinates the molt and juvenile hormone (JH) which determines the type of molt that occurs. In the past insect endocrinology has concentrated on regulation of titers of hormones by secretion and metabolism as the key to this control. Recent studies of the intracellular receptors for these hormones show that hormone response depends on the availability of these receptors which may vary on a tissue- and stage-specific basis. Moreover, in the case of the ecdysteroid receptor, there are different forms which in turn determine which genes can be regulated. Both the quantity and form of these receptors can be regulated by the hormonal milieu with a new form appearing at metamorphosis. The mode of action of JH in preventing metamorphosis is still unclear. A specific nuclear JH-binding protein is present in larval tissue, but disappears when ecdysteroid acting in the absence of JH signals the onset of metamorphosis. This protein does not contain known DNA binding domains but somehow directs ecdysteroid action so that new genes cannot be activated. Two neuropeptides, prothoracicotropic hormone (PTTH) and eclosion hormone (EH), initiate and terminate the molt respectively. Isolation of these peptides and cloning of their genes has allowed localization of the cells and thus physiological studies of their regulation by both internal and external cues are possible. Pure peptides are also being used to study their mode of action and to isolate their receptors.

THE PERIL OF BIODIVERSITY: A PARADOX.
K. C. Kim, Frost Entomological Museum, Department of Entomology The Pennsylvania State University, University Park, PA 16820 USA.

Biodiversity is the living resources of our planet that sustain the process of ecosystems. This very fountain of the process which supports the wellbeing of humans is rapidly being destroyed by impact of technological advancements which brought us healthier, longer life, and material affluence and convenience, and which also resulted in a rapid expansion of human demography and urbanization. These gains in turn transformed this blue planet into a mosaic of human ecosystems in which anthropocentrism dictates how the process proceeds and thus continually aggravates the deterioration of environments throughout the world; and ultimate outcome is the destruction of habitats and biodiversity. It is urgent that the remaining biodiversity perserved and damaged habitats restored with a biodiversity reestablished. We, entomologists, must join in the crusade for biodiversity conservation, particularly for scarcely known arthropod fauna of the world.

DIVERSITY OF TERRESTRIAL ARTHROPODS IN THE NEARCTIC REGION.
H.V. Danks (Biological Survey of Canada (Terrestrial Arthropods), Canadian Museum of Nature, Ottawa, Ontario, Canada K1P 6P4)

The nearctic region includes many different environments inhabited by insects, ranging from arctic tundra to lush forests. About 143,000 species of insects and about 38,000 species of other terrestrial arthropods occur in the region. However, only about 63% of the insects and 29% of the other terrestrial arthropods have been described as adults, and the state of knowledge varies widely among different groups. Less than 6% of the species have been described in the larval stage. High arctic regions are least rich; southern areas contain the most species.

Resources available to study the nearctic arthropod fauna are widely but unevenly distributed. However, the number of systematists is relatively small and is currently in decline. No complete or consistent series of faunal works exists. Substantial collections resources are available, but most collections are suffering from a shortage of resources, especially staff. Such shortages stem partly from the smaller visibility and smaller public funding of museums seeking basic knowledge, relative to organizations with missions to study applied problems. It 's the efore necessary to emphasize that biological knowledge grows by the steady accumulation of information, accessible through species names; and that in any biogeographic region knowledge of biodiversity, based on systematics studies, is required to ensure that the environment is used in a sensible way.

THE INSECT DIVERSITY IN CHINA.
Yan-ru Wu(Institute of Zoology, Academia Sinica, Beijing 100080, China)

Zoogeographically, China possesses both the Palearctic and Oriental characteristics. It is rich in insect resources. A conservative estimate of the number of insect species in China is over 150,000. Except Diploglossata, 33 orders have been studied in different levels. Over 45,000 species have been described in the past years, accounting for about 30% of the estimated total species in China, about 500 new species are described each year. The immature stages have been described only in a few groups. The biology of thousand of economically important species has been studied. China possesses more than ten millions of insect speciemens. There are about 500 insect taxonomists in China. It is still a long way to go for Chinsese systematists to describe the 70% unknown species, to fill the blank groups and to study the phylogeny and zoogeography.

Studies on the precious, rare and endangered species are rather late in China. A preliminary survey on the precious species of butterflies and the rare insect-groups with academic value in systematic of insects has been done by some Chinese scientists recently. The incompleteness makes it very difficult to judge whether it is a threatened or an endangered species and how to protect them.

TOWARD THE GLOBAL DIVERSITY OF ARTHROPODS: SUMMARY AND PERSPECTIVES.
Nils Moller Andersen (Zoological Museum, University of Copenhagen, DK-2100, Denmark).

At the present time approximately 1,5 million species of plants, animals, and microorganisms have been given scientific names. The overwhelming elements of this diversity are the terrestrial arthropods, insects and arachnids, with more than 800,000 described species. Recent surveys of the North American and Australian faunas show that probably less than half of the insect and arachnid species have been described and named in these regions. Current estimates of the World fauna of insects range from 10-80 millions species. The hyperdiversity of terrestrial arthropods, especially in the tropics, is a formidable challenge to biological systematics in general and to entomologists in particular. It is therefore disconcerting that training opportunities for systematic entomologists have diminished over the last decades in both North America and Europe and positions in systematic biology are being closed instead of replaced. Immediate action needs to be taken to repair this unfortunate situation.

LEPIDOPTERA OF THE WORLD. ***N.P. Kristensen*** **(Zoological Museum, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark).**

Estimates of species numbers of Lepidopteran high-rank taxa are presented. In one subset of the Lepidoptera, the butterflies (Hesperioidea + Papilionoidea), the proportion of the extant diversity now described is probably greater than in any other invertebrate group of comparable size. But butterflies particularly clearly illustrate the impact of differences in species concept on estimates of species diversity: Replacement of the current biological species concept (i.e., informed guesses about what are reproductively isolated aggregates) with the phylogenetic species concept ('smallest dignosable clusters...') would probably lead to an increase in recognized numbers of butterfly species (c. 17,000) by at least one order of magnitude.

Documented cases of species extinctions are available, but do not adequately reflect the magnitude of the present environmental crisis.

The current situation of systematic lepidopterology is outlined, and some suggestions for research strategies are made. High priority fields include descriptive morphology of phylogenetic key taxa, global generic classifications of family-group taxa, and regional checklists.

THE WORLD FAUNA AND TAXONOMY OF HETEROPTERA.
Carl W. Schaefer (Dept. Ecol. & Evol. Biology, Univeristy Conn. U-43, Storrs CT 06269-3043, USA)

Based on reports from students of Heteroptera around the world, the following are roughly estimated by geographical Region: the number of Hemiptera-Heteroptera known, and the number of species yet to be described; the number of species whose immatures have been described; the number of species whose biology is known; the availability of keys to and catalogs of the heteropteran fauna; and the number of taxonomists, and amount and sources of support for taxonomic research.

THE GLOBAL FAUNA OF ANOPLURA. K. C. Kim, The Frost Entomological Museum, Department of Entomology, The Pennsylvania State University, University Park, PA 16802 USA

The Anoplura constitutes unique haematophagous obligate ectoparasites of mammals. The global fauna is estimated to be 1,200 species of which approximately one-half has been described. The coevolutionary patterns of Anoplura and mammalian hosts are described and the pattern of historical distribution is discussed.

GLOBAL BIODIVERSITY AND TAXONOMY OF INSECTS AND ARACHNIDS: SUMMARY AND CONCLUDING REMARKS. K.C. Kim, Frost Entomological Museum, Department of Entomology, The Pennsylvania State University, University Park, PA 16802 USA

The issues pertaining to the global biodiversity of insects and arachnids, discussed by regional fauna and by selected taxa, will be summarized and future perspectives discussed.

TRICHOPTERA FAUNA OF THE WORLD.
John C. Morse (Department of Entomology, Clemson University, Clemson, South Carolina 29634-0365 USA)

The world Trichoptera fauna has been estimated to be between 10,000 and 50,000 species, with an especially high species diversity in the Oriental Biogeographic Region. Most species are known only from the male sex, with less than 30% of known species described as larvae, far fewer described as pupae, and virtually none described as eggs. Tropical habitats generally have been explored less than north and south temperate habitats. Research programs in the Neotropical Region, southeastern Asia, and western Africa presently are yielding large numbers of species new to science. Human disturbances in freshwater ecosystems through deforestation and construction in the watershed; organic pollution; and chemical poisoning with pesticides and industrial discharges are taking an apparently large toll on Trichoptera and other freshwater species, driving an undetermined number to extinction. Accurate estimates about extinction rates are not possible without a better knowledge of the species and their distributions, especially in developing tropical countries. Better knowledge of the fauna also will facilitate use of Trichoptera and other aquatic insect species in detection of water pollution, enhancement of fisheries, and ecological studies of freshwater ecosystems.

GLOBAL BIODIVERSITY AND TAXONOMY OF DERMAPTERA WITH SEVERAL BIODIVERSITY-ANALYTICAL TECHNIQUES.
SAKAI,Seiroku(Institute of Biology & Life Sciences,Daito Bunka University,Nr.2-26-12,Sendagi,Bunkyo,Tokyo,Japan 113)

Global biodiversity of Dermaptera is recognized in 4 Suborders,6 Superfamilies,11 Families,55 Subfamilies,208 Genera,1,895 Species,34 Subspecies,37 Varieties and 9 Forms.It is interesting to analyze why the external features of Dermaptera seem to centralize to the biodiversity to the male forceps,pygidium,manubrium and genitalia including the shape of Virga and paramere.on Dermapteran polymorphysim. Analytical techniques for the biodiversity is closely concerned with insect integrated taxonomy or biosystematics.The biodiversity is analyzed from the point of view to Dermapteran fossil,biogeographical dispersal routs,multivariate morphometrics including PCA and clustering analyses, physical taxonomic techniques such as Moiré picture and laser holographic analyses,Chemotaxonomic analyses including metal elements in their hemolymph,ChE,Amino Acid and electrophoretic analyses,cytotaxonomy including C-banding karyotype analyses and Dermapteran bioecology and ethology. Dermaptera frequent crevices under the bark of trees and in fallen logs,and crawl beneath debris on the ground.Their food consists of wide range of living and dead plants and animal matter.Dermaptera damaged to bean,potato,beet,cabagge,cauliflower,pea,carrot,cucumber,dahlia,zinnia, sweet-william berry,radish,strawberry,apple,apricot,peach,pear, plum and grape.The life histories of about 18 species are known. Some species such as*Labidura* and *Euborellia* are effective predator against field crop pests.

CUTICULAR HYDROCARBON OF INSECTS AS CHEMOSYSTEMATIC TOOLS. Chin-Seng Chen (Department of Biology, Tunghai University, Taichung, Taiwan,China)

Analysis of cuticular hydrocarbons by gas chromatography (GC) has been proved useful as taxonomic characteristics in several insect orders, e.g. Diptera,Isoptera, Hymenoptera, Orthoptera and Coleoptera. This technique has also been applied to separate the sibling species and intraspecific geographic strains in the members of mosquitoes, black flies, and sandflies species complexes.

Crude extracts of cuticular hydrocarbons are prepared by soaking the specimens in a nonpolar solvent. The extract is then injected onto the gas chromatograph equipped with a flame ionization detector (FID) and a profile is produced on which each hydrocarbon appears as a peak. Retention time and GC/MS are commonly used for the identification of these peaks. Abundance and number of peaks for different species are compared quantitatively and qualitatively.

An important advantage of GC analysis of cuticular hydrocarbons over other taxonomic technique is the ease of specimen preparation and extraction. Dead or even dried museum specimens are extractable as well as living wild or laboratory-reared material without destruction of the specimens. On the other hand, variations of GC profiles due to ages, diets or other environmental conditions found in some insects could lead to misinterpretation and application to species identification as conventional morphological approach. It is important to take these variations into account when applying this technique and great care should be exercised not to split species on the basis of cuticular hydrocarbon profiles alone.

Karyotypic divergence and speciation in the Australian *Myrmecia (pilosula)* species complex (Hymenoptera; Formicidae), with reference to modern cytological techniques. Hirotami T. IMAI (National Institute of Genetics, Mishima, Japan), Robert W. TAYLOR (CSIRO, Canberra, Australia), Kazuo OGATA (Kyushu University, Fukouka, Japan), Ross H. CROZIER (La Trobe University, Melbourne, Australia).

Myrmecia is one of the worlds most primitive ant genera. It is found only in Australia and New Caledonia. The nominal taxon *Myrmecia pilosula* (Smith) has long been considered to be a 'good' but morphologically variable biological species. On the basis of great cytological diversity (2n = 2-4, 6-8, 10, 12, 15-32) we have demonstrated that it in fact comprises at least 7 independent biospecies. These are morphologically distinguishable using characters formerly considered insignificant, and several species have been collected for the first time during our project. We introduce a novel air-drying method for preparation of ant chromosomes along with modern staining techniques, including C-banding, Ag-staining and biotin labelled *in situ* hybridization. The roles of these techniques in analysis of karyotype evolution in the *Myrmecia (pilosula)* complex are reviewed.

APPLICATIONS OF ISOZYME ELECTROPHORESIS TO INSECT MOLECULAR SYSTEMATICS. William W.M. Steiner (USDA-ARS Biological Control of Insects Res. Lab. Univ. of Mo. Research Park, Columbia, MO 65205, USA)

Application of isozyme (protein) electrophoresis to systematic problems in insect phylogeny has been in vogue since the late 1950's. Early on it was applied not just to Drosophila but also to large mammals and marine invertebrates. The first, early applications to insects were interpreted with respect to Drosophila, resulting in some biases in evolutionary conclusions concerning distinct phylogenies. Correct interpretations enabled the pinpointing of evolutionary problems which were sometimes phylogenetically specific but nevertheless informative, clearly supporting a late observation by the father of experimental population genetics, Theodosius Dobzhansky. The argument is presented and defended that, although the use of DNA for systematic purposes is probably more heuristically accurate at the macroevolutionary level in terms of a base by base comparison, it may suffer from an inability to give an accurate picture of events at the microevolutionary level. The relative importance of the latter to agriculturally important insect phylogenies may have been overlooked.

USE OF THE POLYMERASE CHAIN REACTION IN INSECT SYSTEMATICS AND POPULATION BIOLOGY. D. R. R. Smith (Department of Entomology, University of Kansas, Lawrence, KS 66045 U.S.A.)

The polymerase chain reaction (PCR) allows rapid amplification of selected DNA fragments from minute amounts of tissue. This technique has several applications in honey bee biology, some of which will be discussed, including:

1. PCR amplification of regions of the mitochondrial genome which have restriction site polymorphisms diagnostic for particular subspecies or populations.
2. PCR amplifications of mitochondrial DNA using conserved primers, followed by digestion with a battery of 4- and 6- base restriction enzymes, for rapid survey of populations for diagnostic characters or for generation of characters for systematic studies.
3. Sequencing from PCR amplified nuclear or mitochondrial DNA for systematic studies.
4. The RAPD (Random amplification of polymorphic DNA) technique for detection of nuclear polymorphisms and for chromosome and linkage group mapping.

DNA PROBES FOR THE FIELD IDENTIFICATION OF INSECTS. J.M. Crampton, S. Hill R. Urwin (Wolfson Unit of Molecular Genetics, Liverpool School of Tropical Medicine, Liverpool, UK.)

A number of methods are currently available for insect identification and for taxonomic purposes, including morphometrics, isoenzyme analysis, cuticular hydrocarbon determination and mating incompatibility. The use of DNA probes offers an attractive alternative to these techniques, particularly if such probe systems could be used in a field situation. The strategies which may be utilised to develop species-specific DNA probes for the identification of insect specimens will be discussed with the main emphasis of the presentation being placed on the refinement of cloned DNA probes and the detection systems which may be utilised to make this form of insect identification a truly field methodology.

The definition and construction of synthetic oligonucleotide probes suitable for the identification of species will be described using the *Anopheles gambiae* complex of mosquitoes to illustrate the approach. This type of synthetic probe, either in a modified or unmodified form, used in combination with a range of non-radioactive detection systems, including biotin, digoxigenin, Chemiluminescence and Enhanced Chemiluminescence will also be considered and compared with radioactive labelling and detection. A number of factors relevant to the use of such systems will be addressed in order to define a simplified methodology which is cheap, specific, sensitive and sufficiently easy to use to make it suitable for entomologists in the field.

ENZYME IMMUNOASSAYS FOR THE FIELD IDENTIFICATION OF INSECTS. Akey C. F. Hung (Bee Research Laboratory, Bldg. 476 USDA-ARS, BARC-East Beltsville, MD 20705)

Different techniques have been used for Africanized honey bee (AHB) identification. However, none of these techniques can be carried out in the field. Monoclonal antibodies were used to develop an immunoassay for field identification of AHB. The techniques for developing this assay are described and their applications to other groups of insects are discussed.

WHAT IS THE SISTER-GROUP OF THE EREMONEURA?

Graham C.D. Griffiths (Department of Entomology, University of Alberta, Edmonton T6G 2E3, Canada)

The Eremoneura have been assumed to be the sister-group of the Asiliformia (Pleroneura) by most recent authors, but the characters supporting this grouping are all reduction modifications subject to homoplasy. There is increasing evidence arising from recent investigations of the male genitalia and larval head structure that the Asiliformia (together with Nemestrinoidea) are to be grouped with the Tabaniformia (inclusive of Xylophagoidea). Constitutive characters of this asiliform/tabaniform group include formation of an aedeagal sheath, presence of a pair of ejaculatory sclerites (sensu Ovchinnikova) and presence of a vertically oriented hook of mandibular origin in the larva. Since the Eremoneura lack these constitutive features of the asiliform/tabaniform group, it can hardly be correct to group them with any subgroup of that group. The structure of the larval head and male genitalia suggest that there are 3 major subgroups of the Brachycera, the Stratiomyiformia (including Pantophthalmidae), the Eremoneura and the asiliform/tabaniform group. While the morphological differences between Stratiomyiformia and Eremoneura are fundamental, both groups have in common that the larvae have reduced mandibles with the biting (or scraping) function having been assumed by a hook formed from part of the maxilla. The possibility of a sister-group relationship between the Stratiomyiformia and Eremoneura needs consideration in future studies.

THE SYSTER GROUP OF VERMILEONIDAE, PELECORHYNCHIDAE (INCLUDING GLUTOPS), AND NEMESTRINOIDEA (DIPTERA).

Akira Nagatomi (Entomological Laboratory, Faculty of Agriculture, Kagoshima University, Kagoshima 890, Japan)

It is proposed as a hypothesis that sister group of the three taxa of the orthorrhaphous Brachycera is as follows: Vermileonidae: Apsilocephalidae + Empidoidea + Cyclorrhapha; Pelecorhynchidae (including Glutops): Rhagionidae (neither Athericidae nor Athericidae + Tabanidae); Nemestrinoidea (Nemestrinidae + Acroceridae): Tabanoidea s. str. (Pelecorhynchidae + Rhagionidae + Athericidae + Tabanidae).

It is needless to say that more evidences are necessary for the change from hypothesis to fact.

GENERIC CLASSIFICATION OF THE FAMILY PIPUNCULIDAE (DIPTERA): A CLADISTIC ANALYSIS.

Marc De Meyer (Dept Zoology, Moi University, Eldoret, Kenya), José Rafael (Instituto Nacional de Pesquisas da Amazonia, Manaus, Brazil).

The classification of the higher taxa of the Pipunculidae is analyzed by cladistic techniques. 25 taxa are studied and 117 character states examined for these taxa. Based on the cladistic analysis a classification is proposed, recognizing three subfamilies: Chalarinae, Nephrocerinae and Pipunculinae. The subfamily Pipunculinae is separated into five tribi. Monophyletic groups within these tribi are recognized. The position of Claraeosphaera is unclear. 24 taxa of generic status are recognized. A presumed phylogenetic history of the taxa and evolutionary transformation series for certain characters are extrapolated from the analysis.

EVOLUTION OF 5.8S RIBOSOMAL RNA IN DIPTERA.

Toru Shimada (Department of Agrobiology, Faculty of Agriculture, University of Tokyo, Yayoi, Bunkyo-ku, Tokyo 113, Japan)

Although 5.8S ribosomal RNA (rRNA) of most eucaryotic cells consists of 155-170 nucleotides, two species of insects belonging to the order Diptera have 5.8S rRNA which is split into two pieces of 123 and 30 nucleotides. To learn the origin of split-type 5.8S rRNA, I studied its distribution in other dipterous insects by using denaturing acrylamide gel electrophoresis. Four species of mosquitoes (family Culicidae) had non-split and continuous 5.8S rRNA consisting of approximately 154 nucleotides. A crane fly (Tipulidae), a midge (Chironomidae), a robber fly (Asilidae), and a housefly (Muscidae), on the other hand, had split-type 5.8S rRNA as did a fruit fly (Drosophilidae) and a dark-winged fungus gnat (Sciaridae). These results suggest that the first split-type 5.8S rRNA evolved just after divergence between the ancestor of the mosquitoes and another ancestor in Diptera.

I constructed a genomic DNA library of the mosquito, Culex tritaeniorhynchus and obtained several clones for ribosomal RNA by using a PCR product from conserved primers as a probe. Segments containing 5.8S region were subcloned and sequenced. Computer analysis showed a probable secondary structure of the 5.8S rRNA of the mosquito, which was different from that of the precursors of already-known 5.8S RNA in the friut fly and the dark-winged fungus gnat.

Paraphyletic Groups within the Heteroptera and Their Application for Phylogenetic and Biogeographical Studies

THE STATUS OF INFRAORDINAL RELATIONSHIPS IN THE HETEROPTERA BASED ON MORPHOLOGICAL AND DNA SEQUENCE DATA. Randall T. Schuh (Department of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024-5192, USA)

Few explicit schemes of higher group relationships within the Heteroptera have been proposed. Relationships among the infraorders have been difficult to justify due to the paucity of apparent synapomorphies. In an effort to advance knowledge in the above-mentioned areas, sequence data form 18S RNA was collected for 25 heteropteran taxa representing all infraorders except the Dipsocoromorpha, as well as several outgroup taxa. The monophyly of the six infraorders for which data are available is supported, as is the monophyly of the Heteroptera, Heteroptera + Colerrhyncha, and Heteroptera + Coleorrhyncha + Auchenorrhyncha (in our sample). The higher group relationships independently recognized by Schuh and also by Stys are largely corroborated by the data, lending credence to the hypothesis of phytophagy as a derived condition in the Heteroptera.

PARAPHYLETIC GENERA IN THE SALDIDAE (HETEROPTERA). P. Lindskog (Department of Entomology, Swedish Museum of Natural History, S-104 05 Stockholm, Sweden)

Two cases of evident paraphyletic genera in the subfamily Saldinae are detailed: (1) The Nearctic genus *Ioscytus*, diagnosed by several somatic autapomorphies, is interpreted here as a derived subgroup of the Holarctic *pallipes* species group of the genus *Saldula* (s.s.), as recently redefined. (2) The peculiar monotypic genus *Mascarenisalda*, endemic to Mauritius, is clearly the sister-taxon of "*Saldula*" *madagascariensis*, endemic to Madagascar, the two having close relatives in some African "*Saldula*" spp. These taxa belong to a clade which also includes the monotypic genus *Helenasaldula*, endemic to St. Helena I., several insular "*Saldula*" spp. of Western Tropical Pacific, as well as the 8 species of "*Saldula*" endemic to the Hawaiian archipelago. Alternate classifications and ranking of the two groups of taxa are discussed following the tenet of strict monophyly, and the implications for biogeographic and evolutionary analyses are explored. The nature of the particular characters used to validate monotypic and some other genera in the Saldidae causing the creation of paraphyletic groups is also considered.

GENERAL REMARKS ON PARAPHYLETIC GROUPS WITH EXAMPLES FROM THE ENICOCEPHALOMORPHA AND DIPSOCOROMORPHA. Pavel Štys (Department of Zoology, Charles University, 128 44 Praha 2, Czechoslovakia)

Paraphyly is an ontological phenomenon concerning all stem-lines and frequently also species; consequently, monophyla can be ancestrally paraphyletic. In classifications of modern taxa the paraphyla are artifacts resulting from unwarranted exclusions (owing to autapomorphies) or inclusions (owing to symplesiomorphies). Paraphyla need to be retained as temporary conventions in cases of doubt (Enicocephalomorpha is possibly a paraphyletic suborder) or lacking information (particular to species rich and unrevised, widely distributed genera such as Oncylocotis of Enicocephalidae and Ceratocombus of Ceratocombidae).

COMMENTS ON PARAPHYLETIC GROUPS IN THE PENTATOMOMORPHA WITH PARTICULAR REFERENCE TO THE LYGAEIDAE. Carl W. Schaefer (Dept. Ecol. & Evol. Biology, Univeristy Conn. U-43, Storrs CT 06269-3043, USA) and M.H. Sweet (Dept. Entomology, Texas A&M Univ. College Station, TX 77843, USA)

The heteropteran family Lygaeidae has long been suspected of being at least paraphyletic. We present preliminary evidence to support this view, and consider also other families in the superfamily Lygaeoidea (Colobathristidae, Malcidae, Berytidae, and Piesmatidae).

PARAPHYLETIC GROUPS IN THE GERROMORPHA. Nils Moller Andersen (Zoological Museum, University of Copenhagen, DK-2100, Denmark).

The monophyly of the infraorder Gerromorpha is firmly established by a number of synapomorphies although Cobben initially characterized this group as "a paraphyletic stem-group" within the heteropterous bugs. Several of the more recent improvements in the classification of the Gerromorpha have been achieved by eliminating paraphyletic or even polyphyletic groups. The relict genus Paraphrynovelia (with two South African species) was included in the family Mesoveliidae, but is now placed in a family of its own. The genera Macrovelia, Oravelia (western U.S.A.), Chepuvelia (Chile), Ocellovelia (southern Africa), and Heterocleptes (Old World tropics) have been shifted around among different families of gerromorphan bugs, mostly because these bugs share several plesiomorphic features. Finally, the aberrant, entirely marine genus Hermatobates has been placed in the Gerridae, but deserves a separate family. The consequences of accepting paraphyletic taxa for studies of the historical ecology and biogeography of gerromorphan bugs are discussed.

A CLADISTIC ANALYSIS OF THE BERYTIDAE OF THE WORLD, WITH PHYLOGENETIC INFERENCE CONCERNING THE MONOPHYLY OF FAMILY GROUPS WITHIN THE LYGAEOIDEA. Thomas J. Henry (Systematic Entomology Laboratory, PSI, ARS, USDA c/o National Museum of Natural History, Washington, DC 20560

A cladistic analysis of the heteropteran family Berytidae, commonly called stilt bugs, is presented based on a broad survey of genital and external character information. Thirty-eight genera traditionally have been placed in two subfamilies, the Berytinae and Metacanthinae. This study shows that the metacanthines are paraphyletic, containing taxa representing a third subfamily and several genera belonging in the Berytinae. Phylogenetic analysis of the Berytidae, as well as familial recognition of the Colobathristidae and Malcidae within the Lygaeoidea, provides information that may challenge the monophyly of the Lygaeidae.

Paraphyletic Groups within the Heteroptera and Their Application for Phylogenetic and Biogeographical Studies

REVISION OF THE Cebrenis COMPLEX (HEMIPTERA-HETEROPTERA= COREIDAE-COREINI). Harry Brailovsky (Instituto de Biologia UNAM. Depto. Zool. Mexico 04510 D.F.).

The Cebrenis complex is revised. It consists of 4 genera: Collatia Stal with six species, Petersitocoris Brailovsky with one species, Petersitocoroides Brailovsky with four species, and Cebrenis Stal with 27 species. The genus Cebrenis is further divided into four natural gropus according to the shape of the posteroventral border of the genital capsule (pvp). Within the cinnamomea group the pvp is evenly rounded, without median projection and it comprises 9 species. In the haenschi group the pvp has a median bifid projection and includ 2 species. In the centrolineata group the pvp is slightly convex with a median spine projection and comprises 11 species. In the fourth group nominate colorata group the pvp is conically shaped, evidently protruding and tuberculate without median projection and includ 5 species. The taxonomic value of the external genital plates of the females is discussed. The biology and habits of some of the species are included. Distribution data for the species are given. The genus is considered to be of Neotropical origin.

PARAPHYLETIC GROUPS IN THE COREOIDEA (HETEROPTERA). Xin zheng Li (Invertebrate Department, Institute of Oceanology, Academia Sinica, 7 Nanhai Road, Qingdao 266071, China)

A cladistic analysis of tribes and subfamilies included in Coreidae, Rhopalidae and Alydidae was made in the present paper. The results indicated that both the "Pseudophloeinae" and "Hydarinae" were monophyletic and occupied the two lowest positions in the cladogram in comparison with the other coreid groups. This means the traditional Coreidae including "Pseudophloeinae" and "Hydarinae" is a paraphyletic group. Serinethini (the only tribe of "Serinethinae", Rhopalidae) is a sistergroup with Harmostini in the rhopalid offset of the cladogram, so the Rhopalinae (including all the rhopalid tribes other than Serinethini) is a paraphyletic group. I raised "Pseudophloeinae" and "Hydarinae" to family category respectively, and suppressed the traditional Serinethinae to tribe category (no subfamily ranks were set up in Rhopalidae).

CLADISTIC CLASSIFICATION OF THE BRYOCORINAE (HETEROPTERA: MIRIDAE) WITH THE RECOGNITION OF TWO NEW SUBTRIBES. Gary M. Stonedahl (International Institute of Entomology, 56 Queen's Gate, London, SW1 5JR, U.K.)

Baerensprung, 1860 proposed the subfamily Bryocorinae to include plant bugs with distally dilated tarsi and a single cell in the hemelytral membrane. Many subgroups were subsequently recognized, culminating in the once widely accepted tripartite classification (Bryocorini, Monaloniini, Odoniellini) employed by Carvalho, 1952 in his Catalogue of the Miridae of the World. Schuh, 1976 presented a cladistic classification of the Bryocorinae demonstrating among other things that the Bryocorini and Monaloniini of Carvalho and other authors were not monophyletic groups. Characters investigated in conjunction with the present study, including features of the pretarsus, metathoracic scent efferent system, and male and female reproductive systems, support the classification of Schuh, along with the recognition of two new subgroups, Dioclerina and Rhodocorina, of the tribe Eccritotarsini.

FAUNISTIC STUDIES OF PROTURA IN ASIA. **Gentaro Imadate** (Konodai College, Tokyo Medical & Dental University, Ichikawa, Chiba 272, Japan)

It was 1907 when the first species of proturans was described from Italy by Silvestri. Since then proturan records have been accumulated from various places in the world, and more than 500 species have been known up to now.

In Asia, faunistic knowledge was very poor until 1956, but it has rapidly increased through tireless activities by Asian specialists for these 30 years. For instance, in 1955, 45 species were known from Europe, 21 from North America, 13 from Central America, 4 fromSouth America, 14 from Africa, 10 from Oceania and 2 from Asia (Such dubious species as *Eosentomon jabanicum*, *protapetron indicum* are excluded).In 1991, however, they were 128, 65, 15, 35, 32, 64 and 255, respectively. The most remarkable example is in the case of China. The Chinese fauna has proved to comprise more than 140 species belonging to 30 genera. It must be stressed that not only it is the richest in the number of species recorded in the world, but also it contains almost all the preferable representatives, including such important stocks as *Fujientomon*, *Hesperentomon*, *Huhentomon*, *Sinentomon*, from the view-point of proturan phylogeny.

STRUCTURE AND EVOLUTION OF THE CIRCULATORY ORGANS IN APTERYGOTE INSECTS. G. Pass , A. Hantschk, H. Krenn (Institute of Zoology, University of Vienna, A-1090 Vienna, Austria)

A comprehensive description of the anatomy of the blood vascular system is given for representatives of all higher taxa of the so-called Apterygota. In these insects several blood vessels exist besides the tubular dorsal heart. They have been partly overlooked so far, but demand special interest from the evolutionary and phylogenetic points of view. One specific trait is a vessel ring caudal to the brain encompassing the gut and connecting the dorsal heart with a short ventral vessel. It is found in the Diplura, Archaeognatha and Zygentoma, but has never been reported in the Pterygota. A very similar vessel ring, however, exists in the Chilopoda. The possible symplesiomorphy of this character for the Antennata is discussed. Special reference is given also to the hemolymph supply of the extremities and other long body appendages. Blood vessels exist in the antennae of most insects. Only in the Diplura are they connected to the anterior aorta. In all Ectognatha they are separate from the dorsal heart. Similar blood vessels exist in the long cerci of Campodea, as well as in the cerci and the terminal-filum of the Archaeognatha and Zygentoma.

ULTRASTRUCTURE OF TRACHEAL SYSTEM IN PROTURA. L. Xué (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China), R. Dallai (Department of Evolutionary Biology, University of Siena, 53100 Siena, Italy), W.-y. Yin (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China)

The tracheal system is absent in most of proturan groups except for the families Sinentomidae and Eosentomidae. Ultrastructural study of the tracheal system of *Sinentomon* and *Eosentomon* indicates that the spiracles are simple, concave, cuticular cavities (atria). A globular chamber is present between the atrium and trachea. The atrium of *Eosentomon* is decorated with ridges and has two small holes into the tracheal recesses other than the tracheal opening. The tracheae of Protura are characterized by a high bucking frequency and the absence of intima folds and intertaenidial spaces. The taenidia of *Sinentomon* have a rectangular section and those of *Eosentomon* are gable shaped. The results also suggest that the tracheal recess of *Eosentomon* is a kind of stigmatic gland. In general, the tracheal structure of Protura is different from that of insects, diplurans and collembolans included; instead it is similar to that of some mesostigmata mites. It is proposed that the proturan tracheal system was acquired independently.

SEVEN NEW SPECIES OF THE ISOTOMIDAE FROM XINJIANG (COLLEMBOLA; ARTHROLEONA) . Ren-xin Huang, Zheng-rong Hao (Department of Biology, Xinjiang University, Urumqi 830046, China)

In this paper, seven new species of the Isotomidae are descrbed, which are collected from Xinjiang, China. Seven new species are as follows: 1. Anurophorus baiyanggouensis Huang & Hao sp. nov. , 2 Folsomides urumqiensis Huang & Hao sp. nov., 3. Cryptopygus peijiangensis Huang & Hao sp. nov., 4. Proisotoma xinjiangica Huang & Hao sp. nov., 5. Desoria yinia Huang & Hao sp. nov., 6. Desoria nanshanica Huang & Hao sp. nov., 7. Desoria hongshanica Huang & Hao sp. nov.

All type specimens are deposited in the Department of Biology, Xinjiang University, China.

TWO NEW SPECIES OF *ISOTOBRYA* WOMERSLEY 1934 (COLLEMBOLA: ENTOMOBRYIDAE), A GENUS RESTRICTED TO TERMITE NESTS IN AUSTRALIA. Penelope Greenslade, (CSIRO Division of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia.

The genus *Isotobrya* Womersley 1934 was erected for a species *I. wheeleri* Womersley 1934, from termite nests in Western Australia. A further species, *Isotobrya burraensis* Womersley 1940, was described from a similar habitat in South Australia. The genus was originally placed by Womersley in the family Isotomidae, but is now accepted as belonging to the Entomobryidae. Two new species have been collected recently extending the range of the genus to the Northern Territory and Queensland. All four species in the genus are unusual for inquiline Collembola, in that they are darkly pigmented and possess ocelli. Diagnostic characters for the. genus are the strongly modified foot complex consisting of exceptionally distally inflated tibiotarsal setae or claws. It is suggested that the genus may be related to the more widespread genus *Drepanura*, species of which are frequently found sheltering within entrances of termite nests in Australia.

STUDY OF THE GENUS *FOLSOMINA* (COLLEMBOLA: ISOTOMIDAE) WITH SPECIAL REFERENCE TO A NEW SPECIES FROM MT. WUYAN-LING, EAST CHINA. Lijun Zhao (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China), Hiroshi Tamura (Department of Biology, Faculty of Science, Ibaraki University, Mito 310, Japan)

The third species of the genus *Folsomina, F. wuyanna* n. sp., was found from Mt. Wuyan-ling, Zhejiang Province, east China in 1990. The new species with falciform mucro resembles the type species *F. onychiurina* Denis, 1931 but differs from the latter by the following characters: 1) dentes with 3 dorsal and 21 ventral setae (2 or 4 and 16-20 in *onychiurina* respectively) and 2) ventral tube with 4+4 setae (3+3 in *onychiurina*). But the second species *F. yongxingensis* Chen, 1987 described from Xisha Islands, south China, has bidentate mucro and only 4 or 5 setae on ventral side of dentes. These two characters are not of the genus *Folsomina* but of *Folsomia*. Therefore, *Folsomina yongxingensis* should be renamed as *Folsomia yongxingensis* (Chen).

EXPERIMENTAL POPULATION DYNAMICS OF *DIURAPHIS NOXIA*. Guang-xue Zhang, Jun Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

In the laboratory, age-specific life table parameters, such as the intrinsic rate of natural increase (Rm), the net reproductive rate (Ro), inite rate of increase (λ), mean length of a generation (T), population doubling time (t), birth rate (b) and death rate (d) etc. were also estimated for seven apterous cohorts. The stable distribution of RWA was estimated. High temperature extremes were found to delay development short longevity and reduce fecundity. Low temperature extremes also delay development, but lengthen longevity and recude fecundity. As a consequense, the intrinsic rates of natural increase (Rm), the net reproductive rate (Ro) in extremes were reduced and the population doubling time (t) lengthened as compared with the life table parameters measured under more favorable temperature condition. The experimental population growth parameters were simulated with some models.

TRITROPHIC INTERACTIONS OF RESISTANT AND SUSCEPTIBLE GRAINS, RUSSIAN WHEAT APHIDS, A PARASITOID AND WATER STRESS. R.K. Campbell, D.K. Reed, J.D. Burd and R.D. Eikenbary (Department of Entomology, Oklahoma State University, and Plant Science Research Lab, USDA-ARS, Stillwater, OK 74078 USA.)

The Russian wheat aphid (RWA), *Diuraphis noxia* (Mordvilko), has become a serious pest of grain production in North America. Heavily infested plants exhibit striking damage symptoms including prostration and an inability to achieve proper leaf expansion. Such unrolled leaves may then serve as refugia for aphid colonies. Little is known of the interactions of drought, RWA tolerant or susceptible grains and biological control. This study was undertaken to address questions concerning these interactions using seedlings of susceptible (TAM W-101) or resistant (PI 372129) wheat, susceptible (Wintermalt) or resistant (PI 366450) barley, and the parasitoid *Diaeretiella rapae* McIntosh (Hymenoptera: Braconidae). Results include: drought stressed resistant wheat exhibited a decline in parasitization rate compared to all treatments, apparently because aphids on these plants were less dispersed (less available) and more concentrated in new growth or unrolled leaf areas. These plants also caused a longer parasitoid developmental period and a more male biased sex ratio. Plant structure modifications and abiotic factors such as drought must be included when evaluating tritrophic interactions in promising germplasms.

EXPECTED AND CURRENT SUCCESS OF IMPORTED ENTOMOPHAGOUS SPECIES FOR CONTROL OF THE RUSSIAN WHEAT APHID IN THE UNITED STATES. T. J. Poprawski (USDA-ARS-US Plant, Soil and Nutrition Laboratory, Ithaca, NY 14853, USA), V.F. Eastop (British Museum, Natural History, London SW7 5BD, U.K.)

Exotic pests may pose severe problems in pest management, because their numbers often rise unchecked by the specialized natural enemies which they have left behind in their region of origin. The Russian wheat aphid, probably from the Iranian-Turkestanian range, is a new pest to the major portion of the US small grain belt. About 20 native species of natural enemies of cereal aphids have been identified in the United States. Data on these native natural enemies, coupled with the available damage reports, indicate however that the natural enemy complex resident in North America is not well adapted for the Russian wheat aphid and has little impact on its population levels. While natural enemies appear to be ineffective in controlling the aphid in the US, regions where it is indigenous rarely sustain economic damage, suggesting that specialized natural enemies may regulate the aphid populations in these areas. Over 100 species of natural enemies attack the aphid worldwide. The US pool of natural enemies thus has been and is being expanded by introducing exotic species. However, not all identified natural enemies are equally effective in controlling the aphid. This presentation reviews the current and expected success of exotic natural enemies for control of the aphid in the United States.

IDENTIFICATION OF CEREAL APHID PARASITOIDS BY EPICUTICULAR LIPID ANALYSIS. R. D. Eikenbary, J. W. Dillwith and R. K. Campbell. Department of Entomology, Oklahoma State University, Stillwater, Oklahoma, USA.

Aphids are among the most destructive insect pests in grain production systems. A significant new threat is being imposed by the Russian wheat aphid, **Diuraphis noxia**, greenbug, **Schizaphis graminum.** A great deal of effort is currently being devoted to the discovery and importation of biological control parasitoids for these aphids. The ability to obtain rapid and accurate taxonomic determinations of these parasitoids is vital. However, current efforts are hampered because of a rarity of trained systematists for these taxa and the fact that one important group (**Aphidius** spp.) are difficult or impossible to morphologically differentiate. Given the importance of parasitic Hymenoptera to biological control programs and the difficulty in obtaining accurate species identifications, there has been a clear need to develop methods that can be used for routine species identification. One method that has shown great potential for other insects including the separation of cryptic species is analysis of epicuticular hydrocarbons. Hydrocarbon analysis offers many advantages over other biochemical methods such as allozyme analysis and RFLP mapping of mitochondrial DNA for routine analyses. We have developed such a method for use with several aphid parasotoids. The method is rapid, relatively inexpensive, can be carried out on fresh or dried specimens, requires only small samples, and can be automated.

GENETICS AND EVOLUTION OF GREENBUG, SCHIZAPHIS GRAMINUM (RONDANI) BIOTYPES. Gary J. Puterka, USDA-ARS, Appalachian Fruit Research Station, Kearneysville, West Virginia, 25430, U.S.A.

The inheritance of the biotype trait in greenbugs was investigated using wheat and sorghum cultivars with known resistance or susceptibility. Clones of greenbug biotypes C, E, and F were induced into the sexual cycle, reciprocally crossed, backcrossed and inbred. The progeny that resulted were cloned via parthenogenesis so their biotypic status could be evaluated on three sources of greenbug resistance in wheat ('Amigo', 'Largo', Dickenson S28A) and sorghum ('Piper', Pioneer 8515 & 8493). The data for 'Amigo', 'Largo', DS-28A, 'Piper' and 'Pioneer 8493' suggested that the biotype trait was governed by duplicate genes with dominance and a third modifier gene that, when dominant, epistatically suppressed the expression of one of the duplicate genes. The inheritance of the biotype trait to 'Piper' was recessive and simply inherited. Each specific biotype-plant relationship followed a quasi gene-for-gene relationship typical of parasite-host relationships. There was no evidence of linkage among the groups of genes. This research indicates that the sexual phase of the greenbug's reproductive cycle plays a key role in the evolution of greenbug biotypes.

MODELLING COLD TOLERANCE AND OVERWINTERING OF THE RUSSIAN WHEAT APHID. Richard A. Butts and G. Bruce Schaalje, (Agriculture Canada Research Station, Lethbridge, Alberta T1J 4B1 Canada)

In western Canada, Russian wheat aphids (RWA) increase in number over the summer months (June to August) on grasses and spring-seeded cereals. As these crops mature, the aphids disperse to the fall-seeded winter wheat. The aphid must then overwinter to infest the next spring's crops. The level of infestation, and the severity of damage from one season to the next, depends in part on the ability of RWA to tolerate cold temperatures and survive the winter.

The RWA is considered to be a freezing susceptible insect. Laboratory and field populations of RWA were tested for tolerance freezing and pre-freezing temperatures. Supercooling points were determined for each instar. Sampling indicated that mortality in the field occurred at temperatures much higher than the supercooling points. Therefore, mortality at temperatures above the supercooling point was studied in the laboratory. Aphids were maintained in chambers at -1, -5, -10, -15, and -20°C. At -10°C, 40% of the aphids survived 15 days exposure. However, reproduction and longevity of survivors was affected after only 24 hrs of exposure to this temperature. Based on this data a model describing overwintering survival of RWA was developed.

TAXONOMY OF THE RUSSIAN WHEAT APHID AND RELATED SPECIES. Stoetzel, Manya B. (Systematic Entomology Laboratory, ARS, USDA, Bldg 004, Room 6, BARC-West, Beltsville, MD 20705, USA).

The morphology and taxonomic status of *Diuraphis noxia* (Mordvilko), the Russian wheat aphid, other species in the genus *Diuraphis*, and species in the related genus *Holcaphis* will be discussed.

THE IMPACT AND EXPECTED DAMAGE BY THE RUSSIAN WHEAT APHID IN WEST ASIA AND AFRICA. Ross H. Miller, (International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 5466 Aleppo, Syria)

Throughout most of the rainfed cereal producing region of West Asia and Africa the Russian wheat aphid, Diuraphis noxia Mordvilko (RWA) is a localized pest, causing minor crop losses in drought stressed plants. During normal rainfall years, populations of natural enemies coupled with poor population performance by the aphid appear to maintain RWA at subeconomic levels. RWA depredations become serious during periods of prolonged drought, which are frequently coupled with below-normal winter temperatures. However in Ethiopia and South Africa RWA is reported to be a more economically serious and chronic pest in rainfed cereals. Development of RWA-resistant cereal varieties and the enhancement of non-chemical pest control strategies for wheat and barley should provide adequate protection against RWA.

Details of surveys and crop loss estimates, with emphasis on the region's less developed countries, are discussed.

IG-2 Semiaquatic Bugs (Hemiptera: Gerromorpha, Leptopodomorpha): Systematics, Zoogeography, Ecology and Behaviour

GENERALIZING ON WATERSTRIDERS: WHAT TO GENERALIZE AND HOW FAR? Kari Vepsäläinen (Department of Zoology, University of Helsinki, 00100 Helsinki, Finland)

Waterstriders (Gerridae) are relatively well studied for their evolutionary biology. I shall use existing knowledge on the family to study problems and prospects of generalizing. My approach focuses on (1) the questions *what* (pattern/process description), *how* (proximate mechanisms) and *why* (ultimate reasons/explanations), and (2) the scale of generalization relative to what-how-why. I shall also dwell on expansion of scale horizontally (within an organizational level) versus vertically (from one level of biological hierarchy to another). It seems that extensive comparative pattern description over species, regions and seasons is a prerequisite for successful generalizations aimed towards better understanding of gerrid evolutionary biology.

BIOTIC AND ABIOTIC FACTORS AFFECTING THE DISTRIBUTION OF SALDIDAE IN THERMAL AND SALINE SPRINGS

Vincent H. Resh, Department of Entomological Sciences, University of California, Berkeley, CA 94720 USA

Insects that live in hot, saline waters must cope with two major stresses. Adults of the Wilbur Springs shore bug, *Saldula usingeri* Polhemus, live longer than the closely related, cold spring-inhabiting *Saldula pexa* Drake when cultured in the high salinity water of *S. usingeri*'s habitat (Wilbur Hot Springs, Colusa County, Calif., USA). However, survivorship of the two species is similar in the low salinity water of *S. pexa*'s habitat (Grizzly Springs, Lake County, Calif., 15 km from Wilbur Hot Springs). Tests indicate that *S. usingeri* imbibes fluids from its prey rather than imbibing water from its habitat; in contrast, *S. pexa* imbibes water from its own habitat, and Wilbur Hot Springs water as well. By imbibing fluids from its prey, *S. usingeri* expends less energy for osmoregulation and its intake of toxic ions from Wilbur Hot Springs water is reduced. By imbibing Wilbur Hot Springs water, the potentially coexisting *S. pexa* lacks these advantages. Although abiotic differences may explain *S. pexa*'s absence from *S. usingeri*'s habitats, susceptibility of *S. usingeri* to spider predation may explain the absence of *S. usingeri* from *S. pexa*'s habitats. The sluggishness of many thermal spring Saldids may make them more susceptible to mobile predators.

PHYLOGENY AND THE EVOLUTION OF WING POLYMORPHISM IN WATER STRIDERS (HETEROPTERA: GERRIDAE). Nils Moller Andersen, Zoological Museum, University of Copenhagen, DK-2100, Denmark.

Most water striders (family Gerridae) exibit polymorphisms that affect their flight ability through variations in wing length and flight muscle development. The diverse patterns of wing polymorphism in water striders make this group ideal for comparative studies. Gerrid populations may be either monomorphic long-winged, wing dimorphic (permanent or seasonal), or monomorphic short-winged (long-winged morph very rare). Water striders inhabit various types of freshwater habitats and the adaptive significance of wing polymorphism has been explained mainly in relation to different degrees of habitat permanence.

Patterns of dispersal polymorphism, beside having ecological functions, also have unique evolutionary histories. In order to understand the origin and maintenance of such adaptations, they can most profitably be considered within their phylogenetic context. In this paper, patterns of wing polymorphism observed in temperate gerrid species belonging to the genera Aquarius, Gerris, and Limnoporus are related to reconstructed phylogenies (cladograms) for these genera. In particular, I ask which state (or states) of wing polymorphism were ancestral for these genera, and which pathways have been followed during the evolution of patterns observed among species.

THE HABITAT TEMPLET FOR GERRIDS. John R. Spence (Department of Entomology, University of Alberta, Edmonton, Alberta Canada. T6G 2E3)

Dramatic differences in survival and mass increases are demonstrated for two gerrid species among three natural habitats in central Alberta. In addition, there was significant seasonal and year to year variation. Variation in food availability accounts for little of the variation in gerrid survival. Mean abundance of potential predators is roughly correlated with variation in survival across habitats, but the explanatory power of this variable is weak. All potential predators captured in activity traps or standardized sweep samples (12 taxa in total) were tested for ability to capture and consume gerrid nymphs. These data were standardized and weighted by season-specific estimates of abundance to calculate 'impact coefficients' for each predator. Impact coefficients are summed and used as an estimate of predation pressure experienced by gerrids during each seasonal period. This measure of predation pressure provides a reasonable explanation for variation in gerrid survival observed in exclosures.

MORPHOMETRIC VARIATION IN WATERSTRIDERS: AN INTEGRATED ANALYSIS OF DEVELOPMENT AND EVOLUTION. Christian Peter Klingenberg (Department of Entomology, University of Alberta, Edmonton, Alberta T6G 2E3, CANADA)

Static, ontogenetic, and evolutionary variation in morphometric characters are reciprocally related to each other. Evolution by means of natural selection or random genetic drift depends on variability within populations, which is expressed by developmental processes. Therefore, a complete analysis of the evolution of morphometric characters must take into account all three levels of variation.

This concept is illustrated by an ongoing multivariate study of morphometric variation and allometry in waterstriders. The variation within and between populations is compared using samples of several species of the genera Gerris, Limnoporus, and Aquarius from Europe and North America.

SEASONAL CHANGES IN PHOTOTAXIS OF AQUARIUS PALUDUM INSULARIS AND GERRIS LACUSTRIS LATIABDOMINIS IN JAPAN. Tetsuo Harada (Department of Biology, Osaka City University, Osaka 558, Japan)

Adults of two water striders, Aquarius paludum insularis Motschulsky and Gerris lacustris latiabdominis Miyamoto reveal strong positive phototaxis in Kochi (33.3°N, 133.3°E) from early spring until approximately the summer solstice. Thereafter the strength of their positive phototaxis gradually decreases and ceases in September only in G. l. latiabdominis. On the other hand, the strength is maintained by A. p. insularis until mid-September, and gradually decreases. In November, positive phototaxis ceases and weak negative phototaxis appears in A. p. insularis. In both species, the season when positive phototaxis ceases, is coincident with that when the adults disappear from water surfaces; September in G. l. latiabdominis, November in A. p. insularis. A long-day photoperiod of 14:10 or 14.5:9.5 (L:D) after adult emergence induces stronger positive phototaxis than does a short-day photoperiod of 10:14 or 9.5:14.5 in G. l. latiabdominis or A. p. insularis, respectively. Low (10±2°C) and high (30±2°C) temperatures induce negative phototaxis and strong positive phototaxis, respectively in A. p. insularis. In G. l. latiabdominis, the abrupt reduction in the photophase from 15.5-15.25 h in the field to 14, 12, or 10 h, weakens the strong positive phototaxis of adult specimens in the summer.

The earlier weakening of positive phototaxis in G. l. latiabdominis than in A. p. insularis is associated with the earlier migration to diapause sites, which reduces habitat overlap and the possibility of competition between the both species.

GENETIC BACKGROUND OF DENSITY DEPENDENT WING DIMORPHISM IN A SEMIAQUATIC BUG, MICROVELIA HORVATHI. Masahiko MURAJI (National Institute of Sericultural and entomological Science. Tsukuba, Ibaraki 305, Japan)

A semi-aquatic bug, Microvelia horvathi, exhibit density dependent wing dimorphism. In this case, each individual has the potential to develop into macropterous or apterous adults. On the other hand, the results of selection and crossing experiments indicate that genetic difference also contribute to determination of wing morph of individuals. The pattern of density response determining morph frequency in a population varied among populations which had selected for different directions and among generations which have different genotypic constitutions. Therefore, the pattern of this response may be determined by a genotypic constitution of a population.

Harrison (1980) argued that much of these genetic data can be interpreted in terms of individual variation in threshold response to environmental variable. In order to examine this possibility, laboratory studies were conducted on the relationship between genetic and environmental factors influencing morph determination in M. horvathi. The results of these experiments were analyzed as a threshold character with two or more threshold (Falconer, 1981).

DISTRIBUTIONAL PATTERNS AND BIOGEOGRAPHICAL RELATIONSHIPS OF CHINESE SALDIDAE. Ping-ping Chen (Department of Biology, Nankai University, Tianjin 300071, China), Per G. Lindskog (Swedish Mus. of Nat. Hist., S-104 05 Stockholm, Sweden).

Totally 2 subfamilies, 12 genera and 45 species are reported as a result of a revision of Chinese shore bugs (Hemiptera, Leptopodomorpha, Saldidae) . It turns out that Chinese saldid fauna reveals Palaearctic and Oriental components. The Genera of Chiloxanthus and Calacanthia as well as a new genus Metasalda are of special geographical interest. The origins of northern cold-adapted taxa, including the historical role of China are discussed.

DIAPAUSE INDUCTION IN CENTRAL EUROPEAN WATERSTRIDERS (GERRIDAE, HEMIPTERA) - NEW DATA IN THE LIGHT OF OLD HYPOTHESES.

M. ZIMMERMANN, R. HAUSER AND R. KOEPFLI (Institute of Zoology, Department of Population Biology, University of Berne, Baltzerstrasse 3, CH-3012 Berne, Switzerland)

According to Vepsäläinen (1978) hibernal diapause in Northern European gerrid species is averted by long, lengthening photoperiods, and diapause is always induced by short, shortening daylength cycles with the fourth instar as the last ontogenetic stage sensitive to photoperiod.

Data from laboratory rearings, from cultures in field exclosures, and from "common garden" experiments with waterstrider species from the Swiss Plateau and the Swiss Jura Mountains reveal that diapause induction in waterstriders is a complex, and highly variable phenomenon. Long-term selection experiments with *Gerris lacustris* and "common garden" experiments with *G. odontogaster* suggest a genetic polymorphism in the ability to switch to nondiapause development. In *Aquarius najas* and *A. paludum* adults switch from reproductive "diapause" to "nondiapause" when they are transferred from constant short-day (10L:14D) to constant long-day cycles (18L:6D). At least in some individuals this switch is reversible. In field exclosures nondiapause *G. odontogaster* molt to the adult stage even long after summer solstice. Results from field rearings in three successive years suggest that fluctuating selection on critical photoperiod might explain patterns of variation. Fifth instars and adults of *G. argentatus*, *G. lacustris*, and *G. odontogaster* sampled by mid-October, and reared under constant long-day cycles (18L:6D) at least partly reproduce, suggesting that in such individuals other factors than photoperiod induced overwintering behaviour in the field.

A PRELIMINARY SURVEY OF THE WATER STRIDER FAUNA OF CHINA (HEMIPTERA, GERRIDAE). Nils Moller Andersen (Zoological Museum, University of Copenhagen, DK-2100, Denmark), Ping-ping Chen (Institute of Biological Control, Academia of Agricultural Sciences, Beijing, 100081, China).

A total of 5 subfamilies, 19 genera, and 63 species is reported as the result of a literature survey and preliminary revisions of Chinese water striders (Hemiptera, Gerridae). Thus, about 12% of the gerrid species of the World are known from China. The largest genera are Gerris s.lat. (14 spp.), Rhyacobates (c. 6 spp.), and Metrocoris (13 spp.). The genera Potamobates and Rhyacobates are essentially confined to China and the biggest living gerrid, Gigantometra gigas, occurs on Hainan Island. Otherwise, faunal affinities are with the Palearctic/Holarctic (4 genera), E Asia (1 genus), but especially with the Oriental/Indo-Pacific regions (11 genera). The number of genera and species increases significantly from North to South. In terms of ecological preferences, the Chinese water strider fauna is highly diversified, ranging from freshwater (most genera) to marine habitats (Asclepios, Halobates), from stagnant water (Gerris, Limnogonus, etc.) to flowing water (Metrocoris, Potamobates) and even torrents (Rhyacobates), and from the free water surface (most genera) to wet rocks (Onychotrechus) and humid soil (Eotrechus). The Chinese water strider fauna therefore offers excellent opportunities for comparative, ecological studies.

OCCURRENCE OF THE ELASTIC PROTEIN RESILIN IN THE ENTIRE EXOSKELETON OF THE GERRID INSECTS

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Weis-Fogh (1960) discovered an elastic protein, resilin in the ligaments of a dragonfly. It was later recorded in the jaws of a polychaete worm (Sasikala and Sundara Rajulu, 1978) and among the arthropods it occurs in the eye-lens cuticle, tendon as well as in the arthrodial membranes (Neville, 1975). Resilin was thus known to be present only in certain parts of the body and hence it is interesting that it is found in the entire exoskeleton in gerrid insects Tenagogonus fluviorum and Limnogonus nitidus. Under UV light the whole insect fluoresced light blue. Sections of all the parts of the exoskeleton of these bugs fluoresced vividly and the fluorescence was increased following exposure to ammonia vapour, whereas fumes of hydrochloric acid as well as n-bromosuccinamide quenched it completely; they also showed swelling reactions in formamide and 10% TCA. The sections stained sapphire blue in toluidine blue-light green at pH 4.7 and chromatographic analyses of the hydrolysate of the exoskeleton disclosed two fluorescent amino acids di_ and tri_tyrosine (Rf.0.05 and 0.18). It is suggested that it is the presence of this elastomer protein that provides for the jumping and whirling movements on the water surface, diving into the water as well as chasing and capturing prey, during which acts the body distorts but regains the original shape, in the gerrids.

A PHYLOGENETIC RELATIONSHIP AMONG THE GENERA OF CHRYSOMELINAE. Mauro Daccordi (Museo Civico Storia Naturale, Verona 37129, Italy).

The genera of the subfamily Chrysomelinae are classified and based, as long our Science knows, on characters considers to be of primary discriminating value. Each one of their modification is the consequence of the creation of different genera. A critical investigation on all these differentiated characters brings to induce and come to the conclusion that there is little to be entrasted in them. Knowing that a character normally indicates peculiar functions, its value may differ according to the sistematic group it comes from. The epipleural ciliation characterizes (but it is not sufficient enough) the subtribe Chrysomelina. On the other hand in the Paropsina the latter is used to form the subgenera. In the Entomoscelina it only discriminats a few of the species. A rating of the characters must be based on the morphological and physiological data shown by the larvas and according to their relationship with the environment. This studies has just begun and it is premature to make use of propose a phylogenesis of the Chrysomelinae. A few analyses on the plesio-apomorphic states of differential characters have brought us (on the cases analysed) on a considerable number of genera.

GEOGRAPHIC DISTRIBUTION IN THE ISLANDS OF JAPAN AND SOUTH KOREA OF THE CHRYSOLINA AURICHALCEA SPECIES COMPLEX WITH TWO DIFFERENT CHROMOSOME NUMBERS. Shizuo FUJIYAMA (Department of Biology, Faculty of Science, Shinshu University, Matsumoto, 390 Japan)

The geographic distribution of C. aurichalcea species complex with two different chromosome numbers (the 31 type and the 41 type) were studied to check the phylogenetic relationship between them. The populations of two different types were distributed widely each other but usually allopatrically. The populations with the 31 type were distributed through the most flatlands except on the islands of Hokkaido, Yaku and Miyake, while the ones of the 41 type, at the three islands and the mountainous areas in the main islands of Japan. On the other hand, the individuals with both chromosome types were occasionally collected at the areas of the boundary of both habitats occupied exclusively by the ones of two different types, though their hybrids were scarcely detected. Their gene frequencies of two colour forms are also shown in relation to chromosome numbers. These results are analysed from the topographical, geological, and vegetational view points. Finally, the implication derived from these distribution patterns will be discussed in connection with the phylogeny.

CHARACTER CONGRUENCE STUDIES IN THE ALTICINAE AND GALERUCINAE. David G. Furth (Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138, U.S.A.), Kunio Suzuki (Department of Biology, College of Liberal Arts, Toyama University, Gofuku, Toyama, 930 JAPAN).

Examination of internal and external morphological characters (including male and female reproductive organs, metafemoral spring and tendons, and wing venation), particularly of problematic or "transitionary" genera of the Alticinae and Galerucinae, demonstrated that these genera possess correlated groups of characters revealing both how unusual they are as well as the closeness of these two chrysomelid subfamilies. Several new metafemoral spring morpho-groups were discovered in alticine genera. This study provides the basis for analyzing these characters in many genera of Alticinae and Galerucinae in order to attempt to establish a reliable higher classification of them, especially for the Alticinae.

MOLECULAR PHYLOGENY OF LEPTINOTARSA BEETLES.
Ting H. Hsiao Department of Biology, Utah State University, Logan, UT 84322-5305, U.S. A.

DNA sequencing has rapidly become an important tool for generating molecular data for systematic analysis. DNA sequence data are especially useful for elucidating phylogenetic relationships among organisms. The leaf beetle genus Leptinotarsa, originated from Neotropics, feeds on three plant families-Solanaceae, Compositae and Zygophyllaceae. Evolutionary relationships among species specialized on the three plant families have not been defined. DNA sequencing provides a new approach for assessing their relationships. Polymerase chain reaction was used to amplify mitochondrial DNA (mtDNA) for sequencing. Several primers were used successfully to amplify the 12s-, 16s-rRNA and cytochrome B regions. Double stranded sequencing was used to obtain sequence of the amplified products. This study involved a dozen Leptinotarsa species and a selected number of species from other chrysomelinae genera. MtDNA sequence data were used to reconstruct phylogenetic trees between species groups and among genera. Among Leptinotarsa species, mtDNA generated phylogenetic trees show good agreement with data previous obtained from comparison of host specificity, life history traits, bionomics, and cytogenetics. The mtDNA sequence data of Chrysomelinae genera also yield phylogenetic trees that are congruent with systematic evidence.

REMARKS ON THE BIOLOGY AND BIOGEOGRAPHY OF THE GENUS TIMARCHA (COL. CHRYS.). Pierre Jolivet (67 Bd Soult 75012, Paris, France)

The genus *Timarcha* is a living paradox and although primitive morphologically and anatomically it possesses some apomorphies such as apterism. In certain areas such as the Pyrenees, evolution and speciation apparently continue and species separation is extremely difficult. The majority of adults are aposematically black-coloured, contain toxins and also exhibit reflex bleeding. However a few day-active species, for example *T. balearica* are metallic and two nocturnal species in different subgenera have a cupreous or reddish coloration. The distribution of the genus is somewhat unusual since the majority of species are circum-Mediterranean and western North American. Its absence in the Mediterranean between Derna in Cyrenaica to Anatolia is probably because of desertification of this area, although *Chrysolina* occurs there. Apparently, *Timarcha* species are better adapted to heat than to cold and their subelytral cavities are similar to those of Pimelia. Only a few species survive near the 55 parallel in Europe and *T. intricata* just above the 50 parallel in Canada. Timarcha probably originated during the Jurassic in North Africa or Central Asia in a hot steppe-like environment.

CHRYSOMELID FAUNA OF PENINSULAR MALAYSIA,WITH REFERENCE TO THE SUBFAMILY GALERUCINAE

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ABSTRACT

The Peninsular Malaysian Chrysomelidae is represented by 13 subfamilies, with Galerucinae being dominant. Presently, the Galerucinae is represented by 55 genera, with about 200 species. Comparative study of the galerucine fauna between Peninsular Malaysia and the mainland Oriental Regions (China, Korea and Indochina) shows the occurrence of 140 genera, with 39 genera (28%) exist in both regions. Out of 105 genera recorded in Peninsular Malaysia and Indochina, 37 genera (35%) exist in both regions. Only 16 (29%) out of 55 genera occurred in Peninsular Malaysia are of the Indo-Malayan element. This shows the strong representation (71%) of the mainland Oriental Regions in the composition of the Peninsular Malaysian chrysomelid fauna.

AN ELYTRON TO BODY MESHING MECHANISM OF POSSIBLE SIGNIFICANCE IN THE HIGHER CLASSIFICATION OF CHRYSOMELIDAE. G. Allan Samuelson. (Bishop Museum, P.O. Box 19000-A, Honolulu, HI 96817, USA) An elytron to body meshing mechanism occurs in most groups of Coleoptera and is well developed in Chrysomeloidea -- it is here described and figured with SEM photographs for various Chrysomelidae. The subepipleural surface is modified basally, as is the corresponding surface of the body, and the opposing surfaces have a fine sculpture which interdigitate. These structures are varied in leaf beetles and may be phyletically significant at higher levels, particularly in Galerucinae and Alticinae.

SYSTEMATIC POSITION OF THE SUBFAMILY AULACOSCELINAE (COLEOPTERA, CHRYSOMELIDAE). Kunio Suzuki (Department of Biology, College of Liberal Arts, Toyama University, Gofuku, Toyama, 930 JAPAN)

The subfamily Aulacoscelinae, established by Monrós in 1953, are a small neotropican chrysomelid group comprising about 20 described species belonging to two genera, Aulacoscelis Duponchel et Chevrolat, 1843 and Janbechynea Monrós, 1953. Only several workers have studied this group and discussed on their systematic position (Jacoby, 1880, 1888; Crowson, 1946; Monrós, 1949, 1953, 1954; Medvedev, 1975; Jolivet, 1959, 1988; Suzuki, 1988; and so on). The author has examined most of the type specimens preserved in the Natural History Museum (London), the American Museum of Natural History (Washington), the Museum of Comparative Zoology at Harvard University (Boston), and others. Based on the results of comparative morphology, especially of several phylogenetically important characters (hind wing venation, reproductive systems of both sexes, and so on), the author assumes the systematic position of this peculiar group.

GENOME SIZE, CHROMOSOMES, AND EGG CHORION ULTRASTRUCTURE IN THE EVOLUTION OF CHRYSOMELINAE LEAF-BEETLES. Petitpierre, E., Juan, C. (Lab. Genètica, Dep. Biol. Amb., Fac. Ciències, UIB, 07071 Palma de Mallorca, Spain).

Nearly twenty-five species of Palearctic Chrysomelinae have been microdensitometrically analyzed in their DNA content of Feulgen-stained spermatids. They have shown a very wide range from 0.20 pg to 3.69 pg, of almost twenty-fold. The genome size is significantly correlated with the spermatid area and the whole chromosome area at metaphase I but not with the chromosome number. However, there is a remarkable evolutionary trend towards decreases in genome size, since the plesiomorphous groups like Timarchini and Chrysolinina have higher DNA amounts than the apomorphous ones, Chrysomelina and Phyllodectina. This feature is corresponded with an increase in their modal chromosome numbers, being 2n=20/24 in the former and 2n=34 in the latter, and with their main larval characteristics, non-glanduliferous and glanduliferous, respectively. The decreases of genome size with especialization have been found in other beetles and in many animal taxa. The ultrastructure of egg chorion has been worked out in roughly ten species where the presumed ancestral stage is shown in Timarcha and some 24-chromosomes Chrysolina.

ON THE FAUNA OF CHRYSOMELOIDEA IN THE HENGDUAN MOUNTAINS REGION, CHINA. Shu-yong Wang, Juan-jie Tan(Institute of Zoology, Academia Sinica, Beijing 100080, China)

The Hengduan Mountains Region located at the southeeastern border of the Qinghai-Xizang Plateau, being famous for its physical geography and its fauna and flora. The investigation of insect fauna in this region, carried out by the Insect group of the Comprehensive Scientific Expedition to the Qinghai-Xizang Plateau, Academia Sinica in year 1981-84, shows that the study of the insect fauna of Hengduan Mountains Region bearing on very important significance to the investigations of the origin, formation and evolution of the fauna of Qinghai-Xizang Plateau. The fauna of Chrysomeloidea in the Hengduan Mountains Region is characterized by its complexity, rich of species and higher taxa, and also marked by its very density congregate alpine species. According to the taxonomic identification, up to the present the fauna of Chrysomeloidea there comprises 16 subfamilies, 150 genera and 536 species among them there are 6 new genera and 211 new species. We regard that the key to inquire into the origin and evolution of the insect fauna there is to study the course of formation of the alpine species. According to the analysis of the faunal constitution of many genera of Chrysomeloidea now existing, the Hengduan Mountains Region is not only the certer of distribution and differentiation of species , tyt also very probably, the place of origin of the neighboring faunas.

The Position of Megalopodinae and Zeugophorinae in a Phylogenetic System of the Chrysomeloidea (Coleoptera). Michael Schmitt, Albert-Ludwigs-Universität, Inst.f.Biologie I, Albertstr. 21a D-7800 Freiburg, FRG.

Since Fabricius (1801) it has been supposed repeatedly that Megalopodinae (Me) and Zeugophorinae (Ze) belong to the Cerambycidae, rather than to the Chrysomelidae (e.g. Crowson 1955:150, Suzuki 1988:343). Kuschel & May (1990) described a new subfamily of Leaf Beetles, the Palophaginae (Pa), which also show characters of Cerambycidae. All three subfamilies (MePaZe) possess a mesoscuto-pronotal stridulatory organ (MPO). SEM-investigations revealed that this MPO is probably homologous to that of the Cerambycidae. The most parsimonious explanation is that MePaZe belong to the Cerambycidae, and that their MPO was an evolutionary novelty of the last common ancestor of MePaZe and those Cerambycidae possessing a MPO. Consequently, the traditional Chrysomelidae cannot longer be considered as a monophyletic taxon. - The digitiform sensilla on the distalmost segment of maxillary palpi in MePaZe are arranged in a peculiar alignment. A similar pattern is only found in *Orsodacne cerasi* (Mann & Crowson 1984) and in certain Cerambycidae (e.g. *Callidium violaceum*). A further, strong, argument suggesting closer phylogenetic relationships between MePaZe and certain Cerambycidae are the larval dorsal ampullae in Palophaginae (Kuschel & May) which are widely acceoted as a synapomorphy of the Cerambycidae.

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Morphological adaptation to high mountain of Galeruca species in SW China

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There are two types of elytra in the alpine Galeruca species, one is shorter type, the other is long type. The elytra of the former type are flattened, truncated or rounded at the posterior margins, and the elytral costae tend to disappear, they only present in the species of lower altitute. The hind wings are lacking in this type. With increasing altitude, the elytral punctures become less and finer, the elytral surface becomes smoother and the inner teeth of the claws become smaller. The elytra of the long type are normal in morphology. They possess hind wings. *According to the length of the 3–6 antennal segments, the long–elytra type can be further divided into two groups : the slender antenna and the normal antenna. The* body length of the first group is obviously shorter than its elytra. There is no costae on their elytra. The terminal part of aedegus is swollen, with straight margin at the tip. The body length of the second group is about the same as its elytra. Its elytral costae are distinct, flattened or vague. Its aedegus are normal.

COLOUR VARIATION IN FINNISH *GONIOCTENA* SPECIES (COLEOPTERA, CHRYSOMELIDAE). Silfverberg, Hans (Zoological Museum, Entomology Division, N.Järnvägsgatan 13, SF-00100 Helsingfors, Finland.)

Among spotted *Gonioctena* species a considerable amount of variation has been reported. This variation is continuous rather than strictly polymorphic. The occurrence of recognizable varieties in different parts of Finland has been studied for *G.viminalis* (L.), *G. decemnotata* (Marsh.), *G.linnaeana* (Schr.) and *G.arctica* Mannh. (*affinis* (Gyll. nec L.)). It seems that no significant geographical differences occur within Finland. Contrastingly the total amount of variation seems to be considerably much larger in Central Europe, although the lack of exact numerical values from there makes such a comparison only tentative. These differences may be explained by the post-glacial colonization of Northern Europe.

Taxonomy, Morphology, Biology, Ecology, Physiology, and Biogeography of Trichoptera and Diptera (Chironomidae)

PHYLOGENETIC SYSTEMATICS AND HISTORICAL BIOGEOGRAPHY OF CHINESE TRICHOPTERA. John C. MORSE (Department of Entomology, Clemson University, Clemson, South Carolina 29634-0365 USA), YANG L. and TIAN L. (Department of Plant Protection, Nanjing Agricultural University, Nanjing, Jiangsu Province 210014 PRC.) The Chinese caddisfly fauna, like that of other groups of aquatic insects, is mostly unknown. However, recent cooperation between our universities is helping to improve this situation, making possible the use of these and other aquatic insects in China as sentinels for monitoring water pollution. Phylogenies inferred by us and previous investigators reveal a pattern with considerable Chinese diversification in some families, especially Hydropsychidae and Leptoceridae. The historical biogeographic tracks produced by these phylogenies suggest relatively recent relationships with other parts of the Oriental and Palearctic Regions and with the Nearctic Region; relationships with other regions occurred in more ancient times or perhaps by dispersal, for example from the Australian Region.

A PRIMARY STUDY OF MARINE CHIRONOMIDAE FROM CHINA. Shi-da Wang (Institute of Hydrobiology, Academia Sinica, Wuhan 430072, China)

About 25 marine species beloning to Clunio Haliday, Semiocladius Sublette and Wirth (Orthocladiinae) and Telmatogeton Schiner, Thalassomya Schiner (Telmatogetoninae) of Holarctic region have been described. Only one species, Clunio takahashii(male) from Taiwan Province of China was reported by Tokunaga in 1938. During the period of 1987-1991, four species namely Clunio pacificus Edwards (larva), C. aquilonius Tokunaga (male, female) from Dalian; Semiocladius endocladiae (male, female) from Qingdao, Telmatogeton japonicus Tokunaga (larva, pupa) from Weihai, Qingdao and Zhoushan Islands had been obtained and all were new record in China. The immature stages of these species are living in the intertidal zones, particularly on the rounded rocky shores covered with Ulva lactuca and Endocladia spp.(as C. aquilonius) or stony substrate with filarious alage or with Tetraclita squamosa japonica (as T. japonicus). The adults swarming low over the shore of stony substrate, which in association with Endocladia spp. and filarious alage; the females of C. aquilonius are flightless, with short legs. Information was given on the morphology, ecology and distribution of these species.

STUDIES ON THE EPHEMERIDAE (EPHEMEROPTERA) OF CHINA. Hong-Gui, Jun Zhang and Da-shou You (Department of Biology, Nanjing Normal University, Nanjing 210024, China)

The research on Ephemeridae in China was limited. Only one genus Ephemera and 19 species have preciously been reported in China by Eaton, A.E. (1870-1871, 1892), Mclachlan, A.J. (1904), Ulmer, G. (1912, 1920, 1924, 1936), Navas, P.L. (1930, 1934-36), Yin-chi Hsu (1931-32, 1935-38) and Tshernova, O.A. (1973). In recent years, we collected specimen Ephemeridae, and studied them. As a result, we intend, in this paper, to describe eight new species of Ephemera. These species are E. maoyangensis, E. hainanensis, E. hongjiangensis, E. hsui, E. hunnanensis, E. jianfengensis, E. wanquanensis, and E. zangjianjieensis. One genus Eatonigenia and two species, Eatonigenia chaperi and Ephemera sachalinensis are new records in China. So far two genera and 30 species have been found in China. The number of genus Ephemera species found in China is the highest around the world.

LONG TERM OBSERVATIONS OF CADDIS-FLY POPULATIONS ALONG A RUNNING WATER GRADIENT. Wagner, Rüdiger (Limnologische Flußstation Schlitz des Max-Planck-Instituts für Limnologie, P.O.Box 260, DW-6407 Schlitz, Germany)

More than 70 species of caddis-flies have been recorded from the Breitenbach (Germany) during 22 years of collection in greenhouses along 2km of the stream. Although there were often dramatic differences in specimen numbers between years, patterns of longitudinal distribution along the stream were basically maintained. Significant size and weight differences of females and males were observed between sequential years, which also exhibited species specific patterns along the stream. Data on specimen numbers, size and weight of females and males were used to estimate the extent to which competition, predation, food shortage and physico-chemical factors may have influenced the observed patterns. There does not appear to have been any single controlling factor for all species along the stretch of stream under study. Gradients along the stream (e.g. temperature), site specific factors (e.g. nutrition), and eco-physiological requirements of individual species must be taken into account. Food does not seem to be the limiting factor for shredding caddis larvae. However, for grazers, algal availability may determine a populations success at certain sites, but not across the entire year.

XIAOMYIA, SHANGOMYIA AND ZHOUMYIA, THREE NEW AND UNUSUAL GENERA OF CHIRONOMINI FROM ORIENTAL CHINA (DIPTERA: CHIRONOMIDAE). OLE A. SÆTHER (Museum of Zoology, University of Bergen, N-5007 Bergen, Norway) Xinhua Wang (Department of Biology, Nankai University Tianjin, China).

Xiaomyia aequipedes gen.n.sp.n., Shangomyia imbectinata gen.n.sp.n. and Zhoumyia plauta gen.n. sp.n. from Guandong and Hainan in Oriental China are described as male imagines. Xiaomyia plus Shangomyia may form a separate tribe within the subfamily Chironominae, but are preliminary placed at the base of the Chironomini. They are unique in having scales with 1-2 spurs at apex of all tibiae, but no combs; no dorsomedian eye extension; extended costa; leg ratios of all legs higher than 1.5; and inferior volsellae fused to the gonocoxite. Zhoumyia is a typical plesiomorphic Chironomini either related to Apedilum Townes, Paralauterborniella Lenz, Lauterborniella Thienemann & Bause, and Pagastiella Brundin or to the Endochironomus group of genera.

REVIEW OF DIAMESINAE (DIPTERA,CHIRONOMIDAE) FROM HOLARCTIC REGION. E.A.Makarchenko (Institute of Biology and Soil Far East Branch, Academy of Sciences 690022 Vladivostok,Russia),I.E.Kerkis (Department of Natural Sciences, Novosibirsk University, 630090 Novosibirsk, Russia).

Our current knowledge of Holarctic Diamesinae had shown that 156 species from 11 genera are known. Two species of Arctodiamesa M., 13-Boreoheptagyia B. 95-Diamesa Mg., 1-Kaluginia M., 3-Lappodiamesa S.-T, 5-Potthastia K., 6-Protanypus K., 13-Pseudodiamesa G.(including Pagastia Ol.), 2-Pseudokiefferiella E., 1-Sasayusurika n.g., 7-Sympotthastia P., 8-Syndiamesa K. in genera are represented. Karyotypes of 10 species of Diamesa, 2-Pseudodiamesa, 2-Pagastia, 1-Sympotthastia, 1-Protanypus, 1-Lappodiamesa were published (Michailova,1989; Petrova,1989; Kerkis, 1991). Systematics, karyology and distribution of Diamesinae genera and species are discussed.

SOME ZOOGEOGRAPHICAL ASPECTS OF THE ITALIAN TRICHOPTERAN FAUNA
Cianficconi F., Moretti G.P. (Istituto di Zoologia, Facoltà di Scienze MM.FF.NN., Università Perugia 06100, Italia)

The Trichopteran fauna of Italy is very complex because of the latitudinal distribution of the species along the peninsula, referred to as Alpine, Apennine and insular (Sicily, Sardinia). The alpine species show an affinity with those of the European region, while the apennine species have an affinity with those of the Mediterranean region with examples of tyrrhenian and transadriatic distributions. Numerous endemic subspecies are found in the central Apennines which demonstrate that differentiation is in process. The Trichopteran fauna of Sicily is similar to that of the Southern-Apennines and that of Sardinia is rich in endemic species.

To date, 359 species are know. One genus (Monocentra), 88 species and 24 subspecies are endemics.

THE GENUS *HYDROVATUS* MOTSCHULSKY (COLEOPTERA: DYTISCIDAE) - ITS PHYLOGENY AND ZOOGEOGRAPHY.
Olof Biström (Zoological Museum, Entomology Division, N. Järnvägsg. 13, SF-00100 Helsingfors, Finland)

A taxonomic revision of the hydroporine genus *Hydrovatus* Motschulsky, 1853, belonging to the Hydrovatini, is now being prepared. Some preliminary results are presented here:

1. Character-analysis with determination of polarity resulted in detection of apomorphies indicating monophyly of both Hydrovatini and *Hydrovatus*. A unification of the Methlini and *Hydrovatus* excluding *Queda* is rejected.

2. A new subdivision for *Hydrovatus* is introduced. Previous subgroupings are rejected because they were based on phylogenetically unimportant characters. A division in 15 subgroups is introduced. For most subgroups apomorphies supporting monophyly were found. Two of the subgroups are paraphyletic and probably need further splitting.

3. Zoogeographic review. The genus has a mainly pantropical distribution; some species extending their range to temperate regions. A gondwanian origin is strongly supported by present day distribution. Evolution of new lineages within the genus seems consistent with continental drift.

LABRUM MODIFICATIONS IN THE CAMPODEIFORM AND ERUCIFORM LARVAE OF TRICHOPTERA.
Batta Spinelli G,Moretti G.P. (Istituto di Zoologia,Facoltà di Scienze MM.FF.NN.,Università di Perugia 06100, ITALIA)

The dietary regime of trichopteran larvae is conditioned by the structure of the labrum. As well as the rasping species (Glossosomatidae),there are species which feed by "fishing" with silk nets (Phylopotamidae) . The group distribution along watercourses, from source to mouth,shows longitudinal settlement,conditioned by the type of food gathered (rasping,fishing,preying, algophagus,phytophagus,etc.).

The upper labrum is used in various types of feeding,and is therefore modified in various ways.

Italian larvae were examined in an attempt to explain the type of feeding which occurs based on the form and structure of the labrum. The study was conducted using an optical microscope and SEM.

THE BIOGEOGRAPHY OF GENUS *PSYCHOMYIA* (TRICHOPTERA: PSYCHOMYIIDAE) FROM CHINA.
You-wen Li, Li-xin Tian (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China), John C. Morse (Department of Entomology, Clemson University, Clemson., S.C. 29634-0365, U.S.A.)

The paper deals with the notes of 20 species of chinese *Psychomyia* (Trichoptera : Psychomyiidae) among which 16 species are new to science and their biogeography. The specimens are collected from several southern provinces of China: Anhui, Fujian, Hubei, Jiangxi, Sichuan and Yunnan. A new synonym is also listed.

THE STRUCTURE OF THE PTEROSTIGMA IN TRICHOPTERA.
M.C. Bicchierai and G.P. Moretti (Istituto di Zoologia, Facoltà di Scienze Mat. Fis. e Nat., Università di Perugia, 06123 Perugia, ITALY)

This study deals with the morphology, histology and ultrastructure of the pterostigma in several Trichoptera species of the Italian fauna (Rhyacophila dorsalis acutidens McL., Glossosoma conformis Neboiss, Philopotamus montanus siculus Hagen, Chaetopteryx gessneri tomaszewskii Moret., Consorophilax consors McL., Stenophylax mucronatus McL., Micropterna fissa McL. and Apatania volscorum Moret.) in which this structure is clearly visible.

The pterostigma appears as a dense, opaque, preapical spot of the wing located near the point where the subcosta joins the costa; it usually occurs in the anterior wing.

The pterostigma is a thickened area which contains a haemolimph lacuna; the tissue of the pterostigma has a spongy texture due to the long processes of the epithelial cells beneath the cuticle and the haemolimph-filled spaces where haemocytes circulate.

STUDIES ON CHIRONOMID COMMUNITY IN NANHU LAKE (SOUTH LAKE), WUHAN, CHINA.
Xian-wu Guo (Department of Fisheries, Huazhong Agricultural University, Wuhan 430070, China)

Horizontal samples and vertical-stratified samples of chironomid larvae were taken quantitatively in 1987-1988 and in May, 1991 respectively. Fifteen species belonging to ten genera and three subfamilies were found out, in which Tanypus chinensis Wang, Tokunagayusurika sexpapilosus (Yan & Ye) and Chironomus semireductus Lenz were three dominant forms. The vertical distribution of the larvae occured in bottom sediment obviously, most species were present in 0-20cm while T. sexpapilosus lived in deeper ooze in May-October, 90% in 20-40cm. The average number of individual of the chironomid community was 1392 ind./m^2 per year and 315 in minimum in May, 2941 in maximum in September and 2648 for the second peak in March of the following year. The average biomass was 10.4g/m^2 per year and 22.9g in maximum in December. It is considered that the available food for larvae and the habitat for adult may be important factors for aggregation of lavae, and the vertical distribution of T. sexpapilosus may be due to the temperature above 19°C.

SYSTEMATIC OUTLINE OF OECETIS (TRICHOPTERA: LEPTOCERIDAE). Chen, Y.E. and Morse, J.C. Department of Entomology, Clemson University, Clemson, South Carolina 29634-0365, U.S.A.

Oecetis MacLachlan, 1877, includes about 250 world species. Homologues demonstrating monophyly for the genus include the displaced posterior branch of the median vein in the adult forewing and the asymmetrical male phallic parameres. The genus has been divided into 19 monophyletic subgenera in this study as follows: N. Subgen. A (7 Australian spp.), Oecetinella Ulmer (=Oecetodella Ulmer, 17 Oriental and Palearctic spp.), Pleurograpta Wallengren (25 Oriental and Palearctic spp.), N. Subgen. B (4 Ethiopian spp.), N. Subgen. C (2 Ethiopian spp.), N. Subgen. D (4 Ethiopian spp.), N. Subgen. E (5 Ethiopian spp.), Ptochoecetis Ulmer (1 Ethiopian spp.), N. subgen. F (22 Australian and Oriental spp.), Oecetis MacLachlan (= Aetesis Wallengren, = Friga Milne, = Oecetina Banks, = Setodellina Lestage, 60 Ethiopian, Nearctic, Oriental, and Palearctic spp.), Allotriogametis Wallengren (3 Palearctic spp.), N. Subgen. G (11 Australian spp.), Paroecetis Lestage (= Potamoryza Barnard, 33 Ethiopian, Nearctic, Neotropical, Oriental, and Palearctic spp.), N. Subgen. H (3 Neotropical spp.), Setodina Banks (4 Nearctic spp.), Yrula Milne (2 Nearctic spp.), Oecetodes Ulmer (6 Nearctic spp.), Quaria Milne (4 Nearctic spp.), and N. Subgen. I (4 Neotropical spp.). An additional 32 species are yet unplaced in this classification and the status of genus-group names Pseudosetodes and Haplosetina are undetermined. Three of the subgenera, Oecetis and Paroecetis and Pleurograpta, are represented in Taiwan; to provide phylogenetic and historical biogeographic context for these eight representative species, all of the 118 species in these subgenera are being revised.

BIOSYSTEMATICS STUDIES OF INDIAN CHIRONOMIDAE (DIPTERA). Girish Maheshwari and Geeta Maheshwari (School of Entomology, St.John's College, Agra 282002, INDIA).

Pure taxonomy of Chironomidae of India has attracted the attention of entomologist in the beginning of this century and produced several new species and genera. But the study on their biosystematic is still required a necessary attention and recognition by Indian Dipterologists. Present study has been done to highlight some significant factors required special attention in India are (i) some significant aspect of ecology such as their role in determining water quality and typology of lakes. (ii) demography, population dynamics and distribution, (iii) some important aspect of Chironomid behaviour, (iv) phylogenetic relationship and (v) recognition of special features of their biology.

NEOTENY AND ITS REPRODUCTIVE SIGNIFICANCE IN MORTOGENESIA MESOPOTAMICA (EPHEMEROPTERA,PALINGENIIDAE). Tomáš Soldán (Institute of Entomology, Czechoslovak Academy of Sciences, 370 05 České Budějovice, Czechoslovakia.

Subimaginal and imaginal instars of the oriental mass occurring mayfly Mortogenesia mesopotamica is compressed into a single "adult" stage. Contrary to other mayflies (sporadic neoteny solely in females) this phenomenon occurs in males as well. Distribution of adult and subimaginal cuticular structures and secretion of pharate cuticle with emphasis on external genitalia is described in detail since adult stage of males represents a mixture of two distinct types of cuticle. Reproductive significance of this phenomenon with respect to peculiar unusual day and seasonal timing of swarming, probably due to extreme environmental and predatory pressure, is discussed.

PHYLOGENETIC STUDIES ON THE BAICALININI,A UNIQUE SPECIES COMPLEX OF LAKE BAIKAL (TRICHOPTERA, LIMNEPHILIDAE). Mey, Wolfram (Museum für Naturkunde der Humboldt-Universität Berlin, Invalidenstr. 43, D (O) - 1040 Berlin)

The lake Baikal in Siberia is renowned for its number of endemic genera and species. Among caddisflies the tribe Baicalinini MART. is fully endemic to that lake. It contains 13 species in 2 genera up to now. The species are considered to be tertiary relicts. The morphological characters show a high degree of plesiomorphy and enable the reconstruction of a ground plan for the subfamily Apataniinae. The monophyly and subdivision of the tribe are discussed on the basis of larval and adult morphology.

PREY OF ASOPINE PENTATOMIDS. Carl W. Schaefer (Dept. Ecol. & Evol. Biology, University Conn. U-43, Storrs CT 06269-3043, USA)

Tabulation of published prey records for the predacious pentatomid subfamily Asopinae shows the preferred food is slow-moving soft-bodied arthropods, principally the larvae of holometabolous insects and sternorrhynchous homopterans. There is some evidence that aposematic asopines prey upon aposematic prey, especially chrysomelids.

NUTRITIONAL ECOLOGY OF HETEROPTERA

DAVID LIVINGSTONE, DEPARTMENT OF ENTOMOLOGY, FREDRICK INSTITUTE OF PLANT PROTECTION AND TOXICOLOGY (FIPPAT), PADAPPAI-601 301, TAMIL NADU, INDIA.

Ecological attributes towards the nutritional demands of heteropterous insects offer convincing evidences of the evolution of feeding patterns correlated with reproductive potentialities. While in herbivory, the apparency of these insects is largely governed by the qualitative and quantitative parameters of phyto-chemistry, in carnivory the diversity of feeding strategies are greatly amplified. The intimate linking of nutritional ethology with the nutritional ecology is most convincingly demonstrated in carnivory both by the specialization of the feeding apparatus and by the simplication of salivary systems. While polyphagy and cannibalism in carnivory are nutritional adventures for survival in a drought prone ecosystem where the prey species is scarce, monophagy and host specificity are necessary adjuncts for herbivory among Heteroptera in such an ecosystem. Herbivory and carnivory are nutritional adjustments among members of the same species, depending on the nature of ecological challenges. Even the deadly cardinolides (heart poisons) sequestered by herbivores for their self defense are utilized by their predating reduviids to promote their reproductive potentials.

NUTRITIONAL BASES OF REPRODUCTION IN REDUVIIDAE. Dunston P. Ambrose (Entomology Research Unit, Department of Zoology, St. Xavier's College (Autonomous), Palayankottai - 627 002, India)

Reduviids are efficient predators and many of them are predating upon a number of potential insect pests. Conserving and augmenting reduviids and employing them in the biological control of insect pests have been gaining attention. Development, growth and reproduction of reduviids are influenced by external as well as internal factors. The external factors, such as meteorological factors indirectly govern the reproductive activities through the internal factors. Amongst the internal factors, nutrition seems to be the most crucial single factor in affecting the development and total egg out put in many ways. The profound impact on the post-embryonic development and the predatory potential of the adult can be a reflection on differences in the biochemical composition of prey species the predator encountered during its imaginal moult or immature stages and also due to the prey-predator interaction. Moreover, the limiting factor in the distribution and abundance of reduviids was found to be the prey species available in that particular ecosystem.

HETEROPTEROUS INSECTS FEEDING ON BAMBOOS IN CHINA.

Le-yi Zheng, (Department of Biology, Nankai University, Tianjin-300071, China)

China has a rich bamboo flora and large areas of bamboo thickets and plantations, thus providing a good place for bamboo insect studies. A list of 36 species of bamboo-bugs belonging to Miridae, Lygaeidae, Colobathristidae, Berytidae, Alydidae, Coreidae and Pentatomidae mostly collected by the author is presented. The systematic positions of these species in each family are discussed. Evidences indicate that most of the bamboo-feeding groups have closely related allies feeding on herbaceous grasses, they might be more ancestral than their grass-feeding allies phylogenetically or vice versa; these suggest that in different families of Heteroptera, the bamboo-feeding taxa have arisen independently more than once in different Gramineae-adapted clades. The microhabitats of bamboo-bugs includes 1) under leaf sheath or culm sheath; 2) node; 3) small branch & foliage; 4) inside stem. The outbreaks of Hippotiscus dorsalis (Stal), Cloresmus montanus Hsiao, Elthemidea piceus Zheng and Pirkimerus japonicus (Hidaka) have been recorded in China; the damages caused by bamboo-bugs are discussed.

EVOLUTION OF NUTRITIONAL TYPES IN HEMIPTERA ON THE BASIS OF THEIR SALIVARY SYSTEMS

S. AGNES, NIRMALA COLLEGE, COIMBATORE, INDIA.

Salivary systems, comprising of principal and accessory glands and their conducting ducts, in Hemiptera, have undergone evolutionary changes from herbivory to carnivory. In exclusively herbivorous Homoptera, the principal gland is plurilobed whereas in Heteroptera there is drastic reduction in the number of lobes from herbivory to carnivory and reduction is complete in haematophagous reduviids. Simplication of lobes has lead to complication of hilus with its specialized development and organization of regulatory mechanism by valvular arrangement. Correspondingly, the common duct leading to the syringe is much elongated in herbivores, especially in sternorrhyncha, while in carnivores the ducts on both sides briefly meet before opening into the syringe, suggesting a device to economise saliva release in the latter. The organization of accessory salivary gland from a tubular to a vesicular type, the latter having arborescent tubes entering into intimate association with the crop confirm fluid regulation in carnivores. The looping of the accessory gland duct around the hypopharyngeotentorial complex on either side, within the head capsule, during post embryonic development characterize carnivory. Similarly, the highly convoluted glomerular knots of the accessory gland tube and the interpolation of gular gland lobes at the junction of the tube and the duct characterize Cicadidae. Enzyme analysis suggests direct evolutionary link with the nutritional ecology of these bugs.

THE PATTERNS AND TAXONOMIC IMPORTANCE OF ANTENNAL TRICHOBOTHRIA IN REDUVIIDAE (HEMIPTERA). Wan-zhi Cai, Io Chou (Entomological Museum, Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

Antenna of more than 370 species of assassin bugs in 21 subfamilies from both Old and New World was examined using light and seanning electron microscopy. Not all the reduviids has antennal trichobothria. No sexual dimorphism of their patterns is found. Setae are changeable both in number and patterns in some genera, such as *Rasahus, Ectomocoris,* but are stable in other genera, such as *Tydides, Peirates* ect.. It is difficult to deduce their homologization and evolution among different taxa. The authors held that the antennal tribothria has little use in the phylogenetic analysis but of some taxonomic importanee at generic and specific level in Reduviidae.

EVOLUTION OF SUBSOCIALITY IN ACANTHOSOMATID BUGS.
Shin-ichi Kudo (Entomological Institute, Faculty of Agriculture, Hokkaido University, Sapporo, 060 Japan)

Subsociality including parental care has been known from many species belonging to 50 genera of 15 families of Heteroptera (Tachikawa, 1991), indicating that it has evolved many times in this order. In the Acanthosomatidae, maternal care of eggs and nymphs has been reported in three genera, *Anaxandra, Sastragala* and *Elasmucha.*

In this paper, I deal with the following ecological aspects in several species, especially in *Elasmucha putoni*: 1) clutch size, egg size and fecundity, 2) offspring mortality and its agents, 3) modes and functions of female behavior and an alarm system in offspring-parent interrelations, 4) benefits and potential costs of maternal care, and 5) life-history specialization to host plants.

Selective factors, preadaptation and physiological or ecological constraints on evolution of maternal care in acanthosomatid bugs will be discussed.

BIOGEOGRAPHY OF DROSOPHILID FLIES IN AND AROUND CHINA. Masanori J. Toda (Institute of Low Temperature Science, Hokkaido University, Sapporo 060, Japan)

As China is vast in territory, it stretches over the cold temperate, warm temperate, subtropical and tropical zones, and encompasses a wide variety of natural environments, making it the home of numerous kinds of wild animals, plants and insects. In spite of its importance for studying the evolution of temperate drosophilid flies in the Northern Hemisphere, information on its drosophilid fauna had been almost lacking. Only 28 species had been recorded from mainland China before 1983, when Japan-China joint studies on the taxonomy and evolutionary genetics of Chinese drosophilids started. A great amount of knowledge on drosophilid fauna of mainland China has been accumulated through this joint project. Up to the time of 1991, a total of 327 known species have been recorded from mainland China. Based on the data obtained from different areas of China, i.e., north-eastern, north-western, central, southern, south-western parts, faunal components of these areas are compared with one another and those of surrounding areas. And finally, a hypothesis about the evolution of temperate drosophilids in the Northern Hemisphere will be presented.

FAUNA OF DROSOPHILIDAE OF SOUTH-WESTERN CHINA. Wen-xia Zhang (Kunming Institute of Zoology, Academia Sinica, Kunming, 650107, China)

South-western China streches over temperate, subtropical and tropical zones, and forms a cline in altitute. Because of complicated geographical and natural environments, fauna of Drosophilidae is colorful rich. 23 genera and 310 species which are 92% of Drosophilidae in China, have hitherto been known from this area. Five genera belongs to the subfamily Steganinae and eighteen genera to the subfamily Drosophilinae. Among the genera, Drosophila has about 198 described species, Amiota 31, Lordiphosa 22, Microdrosophila 20, Leucophenga 18. The remaining genera --- Domonyza, Stegana, Paraleucophenga, Mulgravea, Mycodrosophila, Chymomyza, Liodrosophila, Sphaerogastrella, Colessia, Dettopsomyia, Styloptera, Zaprionus, Phorticella, Scaptomyza, Colocasomyia, Nesiodrosophila, Paramycodrosophila, Hypselothyrea --- have less than ten species each. Among 310 species, new species described have 75 since 1981: Drosophila 28, Lordiphosa 15, Amiota 12, Microdrosophila 11. The remaining genera --- Chymomyza, Zaprionus, Phorticella --- have less than ten species each. A new subgroup --- curviceps subgroup of Drosophila immigrans group is established. This subgroup includes D. curviceps, D. spuricurviceps, D. oritisa, D. nigrodigita, D. taipinsanensis and 3 new species collected in Yunnan. This area may be distribution center of some group, such as robusta, quadrisetata, immigrans and melanogaster group of Drosophila, denticeps and nigricolor group of Lordiphosa. There remain, however, numerous undescribed species to be found in the future.

GEOGRAPHIC DISTRIBUTIONS OF THE DROSOPHILA VILIRIS SECTION. Hide-aki Watabe (Biological Laboratory, Hokkaido University of Education, Sapporo 002, Japan)

The genus Drosophila, the largest one in the family Drosophilidae, involves two major phylogenic lineages, the virilis-repleta and the immigrans-Hirtodrosophila Radiations. In the former an early adaptive radiation which produced many species-groups of the virilis Section is supposed to have occurred in riparian environments of the Old World. Until recently, however, there has been a lack of information on these drosophilids in China. We have found many new species of the virilis Section and obtained new knowldge on the geographic distribution in China by our joint study. Further, the quadrisetata and the wakahamai species-groups have been newly established, the first of which is closely related to the okadai subgroup of the robusta species-group and the second of which somewhat to the melanica species-group. These data show that China is a very important area when considering the evolution of the virilis Section.

This presentation deals with geographic distributions of the species or the species-groups belonging to the virilis Section in the world, especially in China.

THE SCAPTOMYZA GENUS-SUBGROUP OF THE ASIAN PART OF THE USSR. V.S. Sidorenko (Institute of Biology and Pedology, Far East Division USSR Academy of Sciences, Vladivostok-22, USSR)

The Scaptomyza genus-subgroup is represented in the Asian part of the USSR by 14 species beloning to 2 genera: Lordiphosa and Scaptomyza. The most rich in species region is the south of the Soviet Far East (Primorye, Khabarovsk-Province, Amur-region, Saghalien, Kurile Is). There are 13 species in this area. One of them reaches Kamchatka. 5 species occur in Siberia. 3 species are recorded from Middle Asia. They are widely distributed in Palaearctic Region, namely S.(H.) unipunctum, S.(P.) pallida, S.(S.) graminum.

Thus, species of this genus-subgroup prefer obviously to territories with relatively damp and warm climate.

BIOCHEMICAL PHYLOGENY IN THE SIXTEEN SPECIES OF THE SUBGENUS DROSOPHILA. Taek-Jun Lee, Eun-Suk Song(Department of Biology, Chung-Ang University, Seoul, KOREA)

Phylogenetic relationships among sixteen species of the subgenus Drosophila in Korea were investigated by starch gel electrophoresis(SDE) and two-dimensional electrophoresis(TDE). It was evidenced that both electrophoretic techniques are adjunctively useful tools in taxonomy. Although the magnitude of genetic differentiation may be different between allozyme loci obtained by SDE and protein loci surveyed by TDE. The biochemical dendrograms in the subgenus Drosophila were constructed by the data sets(SED and TDE) of genetic distance between species. These species can be divided into two phyletic groups, one comprises the virilis, robusta and melanica species groups, while the other includes the quinaria, bizonata, testacea, histrio and immigrans species groups. The genetic relationships were consistent with the results of cluster and cladistic analyses for 30 morphological characters among the sixteen species.

MITOCHONDRIAL DNA DIFFERENTIATION IN SIX SPECIES OF *DROSOPHILA IMMIGRANS* SPECIES GROUP. Chau-ti Ting, Hwei-yu Chang (Department of Plant Pathology & Entomology, National Taiwan University, Taipei, Taiwan 10765, CHINA) and Fei-Jann Lin (Institute of Zoology, Academia Sinica, Nankang, Taipei, Taiwan 11529, CHINA)

Mitochondrial DNA variations of six species of *Drosophila immigrans* species group collected from Southeast Asia were examined by their restriction fragment length polymorphism (RFLP). A phylogenetic relationship of these species was established according to the RFLP data. They diverged into two clusters, *i.e. D. formosana*, *D. immigrans* and *D. tonpua* are one group, and *D. ruberrima*, *D. signata* and Taxon-A are the other. Among *D. formosana*, the strain collected from Thailand showed a unique RFLP morph. One restriction pattern digested by *Eco*RI has the same type as that of *D. immigrans*, although the other five restriction patterns (*Cla*I, *Hae*III, *Hin*dIII, *Sac*I and *Xba*I) are indistinguishable from those of other *D. formosana* strains. Therefore, these results suggested that the populations of *D. formosana* and *D. immigrans* were probably derived from an ancient population of the *immigrans* stem in Thailand.

HETEROCHROMATIN AND CHROMOSOME EVOLUTION IN THE *DROSOPHILA MONTIUM* SUBGROUP. Baimai, V.(Department of Biology, Mahidol University, Rama VI Rd., Bangkok 10400, Thailand)

Members of the *D. montium* subgroup occur in or near the tropical rain forest of Asia. Analysis of metaphase chromosomes from larval neuroblasts of strains from both lab stocks or natural populations of 20 species of this subgroup has revealed a similar basic karyotype (2n=8). Inter- and intra- specific differences in the amount and distribution of constitutive heterochromatin have been observed in the sex chromosomes and/or 4th chromosome. Only *D. birchii* and *D. kikkawai* have been extensively investigated in wild populations. The natural samples of these species exhibited remarkable intraspecific karyotype variation which seems likely to be a result of the acquisition of extra heterochromatin. Thus *D. birchii* showed 3 types of Y's, 4 types of X's and 2 types of 4th chromosomes. A total of 4 types of Y's and 9 types of 4th chromosomes have been found in *D. kikkawai* while the X chromosome was apparently invariable in the gross amount of heterochromatin. Although the functional role and implications of heterochromatin in species differentiation is unclear, such an extensive variation in heterochromatin in these species of *Drosophila* may reflect the heterogeneity of the environment in Asia with its rich flora and fauna, especially the dipteran insects. Our recent work on the population genetics of the Oriental *Anopheles* strongly supports this view.

EVOLUTION OF VITELLOGENIN GENES IN DROSOPHILA. Craddock, E.M. (Division of Natural Sciences, SUNY Purchase, New York, 10577, USA), K.F. Ho, M. Parisi, F. Piano, M.P. Kambysellis (Department of Biology, New York University, New York, New York, 10003, USA)

Molecular genetic analysis of the vitellogenin genes from fifty Drosophila species shows conservation in the overall gene organization. Nucleotide sequences in certain regions of two of the structural genes studied are highly conserved, while those at the 5' and 3' ends show divergence. In addition to extensive nucleotide substitutions, rare individual evolutionary events have resulted in insertion or deletion of multiple nucleotides in specific hot spots in the coding regions, producing proteins of modified size. In the Hawaiian Drosophila, the timing of such events can be determined, one deletion of 21 bases having occurred <1.8 million years ago. In the melanogaster lineage, we have identified a deletion of one of the introns in one vitellogenin gene. Conservation in the 5' and 3' flanking regions of these genes is limited; large nucleotide insertions/deletions up to 200 bases long are commonly found. Such molecular events have been used to determine evolutionary lineages and trace phylogenetic relationships among Drosophila species and species groups.

ECOLOGICAL AND BIOCHEMICAL ADAPTATIONS TO TEMPERATE CLIMATE IN DROSOPHILA. Takashi Ohtsu & Masahito T. Kimura (Zoological Institute, Faculty of Science, Hokkaido University, Sapporo 060, Japan)

Organisms inhabiting temperate regions have evolved various ecological, physiological and biochemical mechanisms to cope with seasonal change in temperature. In Drosophila, D. curviceps makes seasonal migration between highlands and lowlands to avoid the high temperatures in summer and low temperatures in winter. Other temperate Drosophila species usually enter hibernal diapause to survive the winter. In their overwintering, capacity to store energy for winter use plays an important role as well as cold-hardiness. In the melanogaster species group, cool-temperate species accumulate more triacylglycerols than warm-temperate species. Furthermore, the proportion of unsaturated fatty acids is higher and the transition temperature is lower in triacylglycerols from the cool-temperate species than those from warm-temperate species. Subtropical species of this species group do not have diapause nor accumulate so much triacylglycerols as temperate species.

COLD-HARDINESS OF CHYMOMYZA COSTATA (DIPTERA; DROSOPHILIDAE). Ari J. Riihimaa (Department of Genetics, University of Oulu, 90570 Oulu, Finland.)

It was shown earlier that diapausing third (final) instar larvae of Chymomyza costata become freeze tolerant after one month acclimation to 4°C. Their lower lethal temperatures (LLT50) were extended to temperatures below -80°C provided that freezing of body tissues was started by inoculation at near zero temperatures and the cooling rate was slow (0.1°C/min). Here I report on experiments with post-diapause larvae, pupae, and adults done with the same method. The strain used was started from flies collected from Finland, Oulu (65°N). The results were as follows: The LLT50 of larvae tested immediately after transfer from overwintering conditions (4°C) to 16°C was well below -28°C (the lowest temperature used). During the time period of about 10 days preceeding pupation at 16°C, the LLT50 of the larvae increased gradually to about -18°C. The LLT50 of pupae of different ages was about -16°C. The LLT50 of adult flies was about -9°C.

SEASONALITY IN A SUBTROPICAL DROSOPHILID COMMUNITY OF SOUTHERN CHINA. Tong-xu Peng*, Masanori J. Toda**, Li Xie* and Kuan-yuan Shen* (*Guangdong Institute of Entomology, Guangzhou 510260, China; ** Institute of Low Temperature Science, Hokkaido University, Sapporo 060, Japan)

A annual succesive collection was made by retainer traps baited with fermented banana in Dinghu Shan, Guangdong, China from May 1986 to November 1988. Many traps were set at the environments of different vegetation types including river bank forest, monsoon ever green broad leaf forest and pine mixed with broad leaf forest. The baits and sample containers were changed usually 7-10 days.

Over 110 species of 13 genera were collected through this survey. With regard to geographical distribution, 4 species are cosmopolitan, more than 70% of species are Oriental-other tropical type; so far 21 new species from this collection have published. Obviously, subtropical and tropical species dominate the faunal composition of Drosophilidae in Dinghu Shan. This is similar to the character of floristic elements.

A cluster analysis has made by UPGMA, the number of individual is expressed by average number per trap per day. The whole year is divided into 7 clustrs representing a different drosophilid season.

Seasonal occurrence of main compenent species as follows: 1. D.immigrans occurring mainly in spring; 2. Lio. globosa, D. bizonata and D. guangdongensis from early to mid summer; 3. D.dorsocentralis from mid to late summer; 4. D. lineariden tata mainly in late summer; 5. D. biarmipes and D. malerkotliana m. from late summer to autum; 6. Z. grandis, D. trapezifrons, D. tani, D. prostipennis, D. takahashii D. suzukii, D. subtilis commonly abundant from autuman to spring; 7. D. ficusphila, D. albomicans in every season.

On the Phloeothripidae (Insecta:Thysanoptera) of South Korea

Woo, Kun Suk and Cho, Kwang Sun

(Deapartment of Applied Entomology
College of Agriculture, Seoul Nat'l Univ.)

This study was carried to know the fauna of thrips of Phloeothripidae and their relationship to the host plants throughout the country. Including this study 12 species of Phloeothripidae were known in South Korea. They were *Bagnalliella yuccae, Elaphrothrips antennalis, Haplothrips aculeatus, Haplothrips chinensis, Haplothrips floricola, Haplothrips niger, Liothrips glycinicolla, Liothrips piperius, Liothrips vaneeckei, Bactrothrips brevitus, Pyrgothrips miscanthicola, Stephanothrips japonicus* .

Also their host plants were studied. Among them *Haplothrips chinensis* with the broadest range of host plants in South Korea was found from 41 plants.

SOME REFLECTIONS ON THE COMPOSITION OF THE THRIPS FAUNA (INSECTA: THYSANOPTERA) OF BALI ALONG THE BIOGEOGRAPHICAL BALI-LOMBOK LINE. Richard zur Strassen (Research Institute Senckenberg, D-6000 Frankfurt/Main, Germany)

Within Indonesia, Bali is the westernmost island of the Smaller Sunda Islands. The closely neighbouring island to the east is Lombok. Between these two islands, Bali and Lombok, biogeographer have drawn the so-called Wallace Line which indicates some kind of a border between the faunal area of the Oriental Region and that of the Australian Region. During glacial periods in the Pleistocene, Bali was connected with the land mass of Java and even with that of the distant Kalimantan (Borneo), but not so with the nearby Lombok. The channel between Bali and Lombok was at that time insuperable for certain groups of terrestrial animals. This did not apply for most of the insects. Yet it is interesting to analyse the biogeographical distribution pattern of the Thysanoptera fauna of Bali. So far no Australian or New Guinean element among thrips has been detected yet on Bali.

STUDY ON THE THRIPS FAUNA ON GRASSLANDS IN THE SOUTH-EAST PART OF POLAND. Halina Kucharczyk,(Dept of Zoology, Inst. of Biol. UMCS, Akademicka 19 str. 20-033 Lublin, Poland, Irena Zawirska,(Dept. of Applied Entomology, Warsaw Agricultural Uniwersity, Nowoursynowska 166, 02-766 Warsaw, Poland.)

The thrips fauna (Thysanoptera) of the grasslands in the south-east part of Poland has been studied. During the three years (1986-1988) 72 species of Thysanoptera are collected. Many of them are recorded for the first time from this part of Poland. Thrips praetermissus Priesner 1920 is new for this country. Data on the seasonal appearance, sexual relation, host plants and distribution patterns are given for each species.

MORPHOLOGICAL COMPARISON BETWEEN THREE SPECIES OF GENUS OROTHRIPS MOULTON (THYSANOPTERA: AEOLOTHRIPIDAE). Rita Marullo (Dipartimento di Biologia,Difesa e Biotecnologie agro-forestali,Università di Basilicata,Via N.Sauro 85,85100 Potenza, Italia)

The morphological characters to distinguish a South European species of Genus Orothrips Moulton, Ecplectothrips (Orothrips) priesneri Titsch. and two North American species, O. kelloggii Moult. and O.yosemitii Moult.,are illustrated and discussed.

THE TAXONOMY, FAUNA AND ZOOGEOGRAPHICAL DISTRIBUTION OF CHINESE GOMPHID DRAGONFLIES (ODONATA: GOMPHIDAE). Hsiu-fu Chao (Biologieal Control Researeh Institute, Fujian Agriçultural College, Fuzhou 350002, Fujian, China)

Up to the present, 145 speeies and subspeeies in 33 genera and 2 subgenera of gomphid dragonflies are known to oeeur in China. They belong to 4 subfamilies, i. e., Gomphinae (93 spp. in 17 genn.), Onyehogomphinae (41 spp. in 12 genn.), Hageniinae (5 spp. in 1 gen.) and Lindeniinae (6 spp. in 3 genn.). In earlier publieations, *Gomphus* and *Onychogomphus* are 2 very large genera eonsisting of many heterogeneous speeies lumping together. They are divided into 8 and 7 genera respeetively in the present studies. No genuine members of them oeeur in China.

With the exeeption of *Ophiogomphus* (s. str.), all the remaining genera oeeur in the Indo-Chinese Subregion of the Oriental Region. It seems that the Indo-Chinese Subregion may be the head-quarter of distribution from where gomphids spread radially to various parts of the old world. It is of partieular interest to note that among the transregional genera, 10 of them eonstituting a fairly high pereentage 28.5% of the total number of genera oeeur in the Oriental+Eastern Palaearetie Regions.

There are 21 speeies in 16 genera that oeeur in Taiwan. All genera are eommon in both sides of the Taiwan Strait. Among the 21 speeies, 14 oeeur both in Taiwan and Fujian. The remaining 7 endemie speeies are eongenerie with the elosely related members that oeeur in Fujian. It is evident that the Taiwan gomphid fauna is very elose to that of Fujian.

BIOCHEMICAL SYSTEMATICS IN ODONATA: THE MEDITERRANEAN COENAGRIONIDAE. M. Cobolli, E. De Matthaeis (Department of Animal and Human Biology, Rome University La Sapienza, 00185 Roma, Italy), G. Garchini (Department of Biology, Rome University Tor Vergata, 00173 Roma, Italy)

The biochemical approach was up to now scarcely applied to the systematics of the Odonata. In this paper enzyme electrophoresis was used to study genetic relationships of Mediterranean Coenagrionidae, in order to clarify the systematic status of some controversial taxa. The genetic divergences among several populations of ten species belonging to the genus Ceonagrion, Cercion, Erythromma and Ischnura were estimated on the basis of allele frequencies at twentytwo loci. The results are discussed with respect to the systematics of the group and to the palaeogeography of the Mediterranean area.

LEPIDOPTERA PHYLOGENY: WHERE ARE WE, AND WHERE DO WE GO FROM HERE? ***Niels P. Kristensen*** **(Zoological Museum, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark).**

The phylogenetic classification of the Lepidoptera is outlined on the basis of a score of workers' contributions to the forthcoming treatment of the order in the HANDBOOK OF ZOOLOGY series. We now have reasonable working hypotheses about the interrelationships of a number of basic clades, but major problems remain, including the primary divisions within the Heteroneura and Ditrysia; also, there is a marked lack of cladistic resolution at some subordinate levels within the Ditrysia.

While nucleotide sequencing data bearing on Lepidopteran phylogeny are now anticipated with much interest, comparative morphology has not outlived its usefulness; indeed it is still in an initial phase. Some particularly promising fields for future research are identified, including, e.g., the structure of the proboscis, visual organs, thorax (incl. cervix and thoraco-abdominal junction), phereomone glands, gut, spermatozoa, and larval appendages. Experience teaches us to expect much homoplasy in all kinds of characters, but the hope is that, when many characters are analyzed, the synapomorphy 'signal' will stand out from the unordered homoplasy 'noise'.

PHYLOGENY OF THE DITRYSIA (LEPIDOPTERA): THE IMPORTANCE OF MORPHOLOGY. M.J. Scoble (Dept. of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK)

CURRENT CONCEPTS OF TORTRICID PHYLOGENY AND CLASSIFICATION. Horak, Marianne (Australian National Insect Collection, CSIRO, GPO Box 1700, Canberra, ACT 2601, Australia).

Though the modified, flat ovipositor lobes have been recognized as a tortricid apomorphy, together with a distal eversible portion of the vagina possibly acting in flattening the often characteristically scale-shaped tortricid eggs, the sister group of the Tortricidae still remains unidentified. However, there is strong evidence that larvae of early tortricids were not borers.

A consensus is emerging with regard to the higher classification of the family, with increasingly more higher taxa supported by apomorphies. And though the larger olethreutine tribes are still para- and polyphyletic, monophyletic subgroups are slowly being assembled.

SOME CURRENT DEVELOPMENTS ON THE HIGHER CLASSIFICATION AND EVOLUTIONARY SYSTEMATICS OF BUTTERFLIES. R.I.Vane-Wright (Biodiversity Division, Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK)

Two areas of current research will be reviewed. The first concerns an account of the higher classification of butterflies by P.R.Ackery, R.de Jong and R.I.Vane-Wright for the Lepidoptera volume of the Handbook of Zoology. The aims of the review will be discribed, with particular reference to expectations for future development.

The second topic concerns work by M. Boppre, S.Schulz and R.I.Vane-Wright on the cladistics and chemoecology of Amauris butterflies. This Afrotropical genus of the Danainae shows great elaboration in both morphology and chemistry of the male scent organs. A combination of morphological and chemical data has permitted a refinement of the existing cladistic classification. The next step will involve appraisal of alternative theories linking chemical diversity with the evolution of species-specific signalling in mimetic butterflies.

Phylogenetic Analysis of Basal Lepidoptera Using Multiple Nuclear Gene Sequences

Timothy P. Friedlander[1], Brian M. Wiegmann[2], Jerome C. Regier[1,2] & Charles Mitter[2]

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Gene sequences are a potentially useful source of phylogenetic information for higher-level studies of insects, including speciose groups such as the Lepidoptera, whose major lineage -- the Ditrysia -- remains largely unresolved. As a measure of their utility, several previously untested nuclear genes have been sequenced from representatives of the basal lepidopteran lineages whose cladistic relationships are well supported from previous morphological studies. Our analyses demonstrate concordance of phylogenies based on data sets from distinct genes and from morphology. These studies are now being extended to more problematic areas of lepidopteran systematics.

INTERNAL FEMALE REPRODUCTIVE ORGANS AND THE PHYLOGENY OF THE NYMPHALIDAE (LEPIDOPTERA). Christoph L. Häuser (Zoologisches Museum Alexander Koenig, Adenauerallee 150-164, 5300 Bonn, Germany)

The Nymphalidae are the second largest family of the true butterflies (Papilionoidea) and comprise worldwide about 6.000 species. Although many groups of the Nymphalidae are well known both morphologically and ecologically, their phylogenetic relationships are not well established and the higher classification of the family is under much debate.

Comparative morphological studies of internal female reproductive organs yielded several new characters, which can be interpreted phylogenetically. The Nymphalidae including Libytheinae can be recognized as a monophyletic group by the presence of a secondary postabdominal glandular organ (von SIEBOLDs gland). Apomorphic conditions of the spermatheca, the spermathecal gland, and the bursa copulatrix support the monophyly of several groups within the Nymphalidae (Melitaeinae, Danainae + Ithomiinae, Argynninae + Heliconiinae). Most of the groups defined by internal female genital organs correspond well with current classifications.

A NEW SPECIES OF THE GENUS SICCIA (LEPIDOPTERA: ARCTIIDAE) FROM THAILAND. Angoon Lewvanich (Entomology and Zoology Division, Department of Agriculture, Chatuchak, Bangkok 10900, Thailand)

A species of the Arctiid moth in the genus Siccia is found to be new to science. The larvae feed on lichen growing in the orchid nursery especially on the orchid roots. The taxonomic characters used for identification of this species have been examined. In studying the life cycle, the external morphology and the duration of each developmental stage from the egg to the adult are observed. This species is useful as a biological agent for controlling lichen in the orchid nursery so that chemical sprays are unnecessary.

SEVERAL PROBLEMS CONCERNING LYCAENIDAE AND THEIR FOOD PLANTS. Ryoichiro Kawai (Kanazawa Institute of technology, 7-1 Ohgigaoka, Nonoichi, Ishikawa 921, Japan).

From the standpoint of phylogenetic taxonomy, larval food plant of 2 large groups of Lycaenidae: Thecline-group and Polymmatine-group suggest the possibility of a new system of phylogeny of Angiosperms. The main spectrum of food plants of Thecline-group varies from AMENTIFERAE to SANTALALES, PROTEALES. On the other hand, the spectrum of foodplants of Polyommatine-group varies from ROSALES, LEGUMINALES to EBENALES, MYRSINALES. These 2 spectra cross at a point near to HAMAMELIALES, RHAMNALES. These situation enables us to find affinities of the genera or families of Angiosperms. To do this, because the origin of AMENTIFERAE is very far at least 110 my B.P., various kind of supports are necessary from other branches of science for the description of the confrontation of the ancestors of AMENTIFERAE against the ancestors, i.e. the descendants of GLOSSOPTERIS. Concerning this point, a certain kind of geophysical hypothesis on equatorial transition is also necessary, which serves as a basis for considering the distributions and connections of lands in each geological age of the Earth.

TRANS-JAPAN SEA DISTRIBUTION OF SOME SKIPPER SPECIES (LEPIDOPTERA: HESPERIIDAE). Hideyuki Chiba
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3050 Maile Way, Honolulu, Hawaii 96822, U. S. A.)

Britain and Japan are two of the best-studied areas in the world. Although these two areas are located at the opposite sides of Eurasia, their faunal elements superficially resemble each other.

In Hesperiidae, 6 genera (among 8 British and 17 north Japanese genera) and 4 species are considered to be common. These 4 species were classified into the Palaearctic (Pyrgus malvae and Ochlodes venatus) and the Holarctic (Hesperia comma and Carterocephalus palaemon) elements.

Evans (1949) recognized 5 allopatric subspecies of O. venatus: faunus from Europe, hyrcanus from Iran, sagittus from West China, similis and venatus. He noticed that venatus was genitalically different from similis. It is found that similis and venatus fly together widely in the Far East. Therefore, two taxa, hyrcanus (with subspecies faunus, similis and sagitta) and venatus, should be separated.

Hesperia florinda, which is often considered a subspecies of H. comma, and Pelopidas jansonis show the same distribution pattern as that of O. venatus. Geological events related to this distribution pattern are considered.

SPECIES DIFFERENCES IN THE EGGS OF CLOSELY RELATED BOMBYCOID MOTHS. Kenneth D. Fairey (P.O. Box 42, Revesby, NSW, AUSTRALIA, 2212).

Egg shape, size, colour, and chorionic patterning, reflect basic differences which may enable species diagnosis in Lepidoptera.

In Australia apparently rapid speciation in some Bombycoid moth families, such as the Anthelidae, has resulted in groups of species with overlapping colour variation, and only small morphological differences in the adult moths. In these species groups, egg shape and size can sometimes be used for species separation; but colour, micropylar or chorionic patterning, or a combination of these characters, may be more definitive.

Various attributes of the eggs, when combined with electrophoretic studies of either larvae or adults from the same population, can be used to define both population and species limits. Sometimes these combined studies can also be used for generic differentiation.

BIOGEOGRAPHY OF THE GENUS *CALETA* (LEPIDOPTERA, LYCAENIDAE)

Toshiya Hirowatari
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University of Osaka Prefecture, Sakai, Osaka, 591 Japan)

The genus *Caleta* Fruhstorfer (Polyommatinae) is distributed from India to New Guinea. It contains 9 species with some endemic species occurring from Borneo, Sulawesi and Philippines.

The phylogenetic analysis and distribution pattern of *Caleta* spp. indicate that Sulawesi has some biogeographical association with Borneo, as well as with Mindanao. The inferred phylogenetic relationships of *Caleta* spp. also show that the Sulawesi-Mindanao relationship, which has been pointed out in Notodontidae, Limacodidae (Holloway, 1986) and Tineidae (Heppner, 1989), may reflect much older geological event or biogeographic relationship than in the Sulawesi-Borneo relationship.

ENTOMOLOGICAL RESEARCH, DEVELOPMENT AND APPLICATION: NEW ORIENTATIONS AND APPROACHES. D. Bap Reddy (2-2-18/17/c Durgabai Deshmukh Colony, Bagh Amberpet, Hyderabad 500 013, A.P. India)

Entomological problems need to be perceived in context of development of concerned countries. Agricultural development, systems and patterns must form a firm and realistic basis for research approaches. In most less industrialised countries 50 to 80 % people contribute to farming and depend for living. New skills and technologies should harmonise with their backgrounds, experiences and environments, resulting in new orientations and strategies. Thus Land to Lab to Land and Problem Solving approaches and strategies become essential.

This paper emphasises some aspects of approaches to entomological problems. Advantages of learning from field observations are presented. Reasonable and old practices and environmental approaches are suggested. Insects, like any other organisms, need to be studied and understood in their environments. There is much to learn from the past and quite a bit to take from the present.

Socio-economic, environmental, educational, research, extension, development and institutional aspects are discussed.

OBSERVATIONS ON THE MALE EXTERNAL GENITALIA OF LEPIDOPTERA. HUMAYUN MURAD (Department of Zoology, Aligarh Muslim University, Aligarh202002, India).

The copulatory apparatus in the males of Lepidoptera has become of paramount importance because of its utility in pest identification as well as, its high degree of development. However, much confusion has been created due to coining of new names for each component of the genitalia.

The male external genitalia consists of unpaired aedeagus and a pair of parameres. Present observations, based on Spodoptera mauritia B. and other members of the Order Lepidoptera, donot favour any analogy or homology of the male external genitalia with the legs and therefore, none of the components can be similarised with the coxopodite. These components are independent structures developing from a pair of 'primary phallic lobes'. Similarly, 'claspers' wherever present have nothing to do with the parameres and may be taken as independent appendages, comparable with the styli of apterygote insects.

The present study also emphasises the role played by the genital as well as, postgenital components in the functioning of the copulatory apparatus.

MIMICRY - A TOUCHSTONE FOR DARWINISM. R.I.Vane-Wright (Biodiversity Division, Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK)

Bates' theory of protective mimicry was based on his intimate knowledge of Amazon butterfiles, and the inspiration of Darwin's Origin. One of the first and most compelling examples of evolution by natural selection, mimicry has a special place in the history of evolutionary biology. This is because the precise 'goal' of the selective process, the superficial but exact simulation of the signal pattern of the model, is explicit, as is the selective mechanism. Because it was felt that "the theory that explains mimicry explains evolution", Bates' idea enthralled both pro-Darwinists and anti-Darwinists alike: the fight for or against Darwin could be won or lost by proving or disproving the theory of mimicry. In the event, Bates' protagonists won the battle but probably lost the war: mimicry has been marginalised to the extent that it gets barely a mention in many modern evolution textbooks. Thus the fate of the subject has been mixed: literally thousands of papers refer to Bates and to mimicry, but the subject has not been developed to its full potential. Reasons for this loss of interest, and some of the untapped potential of the idea forever associated with the name of Bates, will be reviewed and discussed.

BATESIAN BUTTERFLIES: THE EMERGENCE OF EVOLUTIONARY LEPIDOPTEROLOGY. Gerardo Lamas (Museo de Historia Natural, Universidad Nacional Marcos, Apartado 14-0434, Lima-14, Peru)

Henry Walter Bates eleven years in Amazonia provided the scientific world not only with an astonishing number of new species of insects, but also one of the most powerful arguments used by Charles Darwin to support his theory of evolution by natural selection. The phenomenon of mimicry was explained cleverly for the first time by Bates, using Lepidopterans as examples, based on his unrivalled knowledge of the ways, habits and geographical distribution of Amazonian butterflies. His everlasting contributions to systematic and evolutionary lepidopterology have proven him right, when he predicted that "...the study of butterflies will some day be valued as one of the most important branches of Biological science." Bates' contributions to lepidopterology and evolutionary theory are examined critically herein, giving special emphasis to his pioneering biodiversity surveys, his ideas on butterfly classification, and his observations on the behavior and spatial and temporal distributions of butterflies in Amazonia and elsewhere.

THE ORIGIN, DEVELOPMENT, FLOURISH AND DISAPPEARANCE OF THE LATE MESOZOIC JEHOL BIOTA IN EASTERN ASIAN PALEOCONTINENT. You-chong Hong (Institute of Natural History, Beijing Natural History Museum, Beijing 100050, China)

The paleogeography of the late Jurassic, the Early and the Late stages of the Early Cretaceous, including the divisions of paleogeographic districts and their volcanoclastic rocks and sendimentary districts, paleomountains, marine sendimentary districts, and their representatives of the stratigraphic units and various fossil assemblages, fauna, flora are described (Tab. 1).

On the bases of above materials, the author has suggested on the rugularity of the origin, development, flourish and disappearance of the famous and special Jehol Biota in the EAP and the distribution of its spread and migration, and then proposed the top and the bottom boundary lines of the Jehol Group at the longitudinal geological section.

The paper suggests again that the Jehol Biota originated from North China, then it spreaded to other places, including Mongolia, Siberia and Eastern Transbaikalia of USSR, and formed a unique Jehol Biota, distributed at about longitude 90^{o}-135^{o}, latitude 25^{o}-57^{o} (Fig. 1).

A COMPARISON BETWEEN THE FAUNAE OF SUBORDER CAELIFERA OF NORTH AMERICA AND EURASIA. Yin Xiangchu (Northwest Plateau Institute of Biology, Academia Sinica, Xining, Qinghai 810001, China), Liu Zhiwei (South and Central China Forestry College Changsha, Hunan 412006, China)

This Paper deals with a comparison between the faunae of grasshoppers and locusts (suborder Caelifera) of North America and Eurasia.

1. There are 7 families with 218 genera in North America and 5 families with 564 genera in Eurasia.

2. Among 770 genera from Holarctic Region, there are only 12 genera (*Schistocerca, Melanoplus, Podisma, Zubovskya, Sphingonotus, Stethophyma, Chorthippus, Chrysochraon, Aeropedellus, Paratettix, Tetrix* and *Tridactylus*) and just one species (i.e. *Melanoplus frigidus* Bohema) distributed in both regions together.

3. The important pest species of grasshoppers in both regions are different. We must prevent them in intercontinental spread.

GRASSHOPPER SPERM COMPARISON IN CHINA. Geng-si Xi, Zhe-min Zhen (Institute of Zoology, Shaanxi Normal University, Xian 710062, China)

The spermatozoa and the spermatids in 33 species belonged to the families of Pamphagidae, Pygomorphidae, Catantopidae, Oedipoidae, Arcyteridae, Gomphocridae and Acrididae from Acridoidea were studied systematically in this paper. Except for some data was quoated from B. Baccetti (1987), most of the materials were collected by myself from Gansu, Ningxia, Shaanxi and Neimongol Autonomous Region in China.

As a result of analysis, seven families in Acridoidea can be grouped under three heads. Because of special centriolar adjunct and the large mitochondrial derivatives, it is clear that Pamphagidae is a more primitive group. Pyrgomorphidae is higher in evolution than Pamphagidae according to the appearance of longitudinal cristae in the mitochondrial derivatives.

Catantopidae, Oedipodidae, Arcyptcridae, Gomphoceridae and Acrididae consist of the highest group distinguished the appearance of a large number of both laminae in the centrioler adjunct and longitudinal cristae in the mitochondrial derivatives. On the other hand, we realize that sperm of Acridoidea changes with the structures of mitochondrial derivatives and centriolar adjunct mainly in the evolutionary lines. The spermatids at a certain stage in their spermatagensis may show anobvious difference among the typical primitive spermatozoa, on the contrary, the resemblance is indicated in the modified sperm.

THE RAPHIDIOPTERA OF ASIA: A REVIEW OF PRESENT KNOWLEDGE. Horst Aspöck (Dept. of Med. Parasitology, Institute of Hygiene, Kinderspitalgasse 15, A-1095 Wien, Austria)

During the past thirty years the insect order Raphidioptera (with its two families, Raphidiidae and Inocelliddae) has been the subject of extensive systematic, biological and zoogeographical studies on a world-wide scale. The order, whose distribution is a distinctly Holarctic one, reaches the southern borders of its distribution in Asia along a line marked by records in Israel, in the north of Iraq, Iran, Pakistan and India, in Birma, and in the north of Thailand and Vietnam. So far about 80 species of Raphidiidae and 10 species of Inocelliidae have been found in Asia which makes up almost 50 % of the known world fauna. By far most of these have been recorded from Mediterranean or Central Asian parts respectively, very few are known from the far eastern and southeastern parts. Although a number of species is still to be discovered in Asia, the main distributional features have to be regarded as clarified, thus allowing zoogeographical conclusions of general significance. The biologies of most of the species of the western parts of Asia as well as their larvae have largely been studied, while those of the species occuring in central and eastern parts of Asia are very poorly known, thus offering a large open research field.

CYTOTAXONOMIC STUDY OF CATANTOPIDAE IN CHINA(ORTHOPTERA: ACRIDOIDEA). En-bo Ma (Department of Biology, Shanxi University, Taiyuan 030006, China) , Zhe- min Zheng (Institute of Zoology, Shaanxi Normal University, Xi'an 710062, China).

The cytotaxonomy is the important part of integrated taxonomy, the chromosomal characters embody the special status of species, therefore, they provides useful evidences for verifing the taxonomic category of living organisms in classfication. In this present paper, the conventional and C-banding karyotypes of all the 66 species belonging to 41 genera in 5 subfamilies of Catantopidae have been systematically comparaed among species and genera. Among them, the species of genus Oxya and Caryanda have been analysed by C-banding karyotypes in detail, the Ag NORs of 10 genera have been studied. In addition, all the C-banding statistics have been calculated by the IBM microcomputer. The results show that the character of C-banding constitute heterochromatin can show the taxonomic relationships among species in the same genus and the locations of NORs can display the common source of the species in same genus, this can be used for comparing the relationships among genera. The chromosomal numbers and the models of chromosomal groups can classify the categories of families and subfamilies. The conclusions above provied some references for using the correspondent marks in cytotaxonomy.

ON TAXONOMIC SYSTEM OF THE MEALYBUG SUBFAMILY: SPHAEROCCINAE. Gui-biao Han, Jin-juan Hao, Yuan Tang, Fang-teh Tang (Agricultural University of Shanxi, Taigu, 030801, China)

Sphaeroccinae belonging to Homoptera: Coccinea: Pseudococcidae, is a cryptic inhabited group that lives on roots under ground and beneath leaf sheathes of plants. The body of the mealybug is tiny and with highly degenerated and specialised morphological features, so it is very difficult to recognize them and their systematic position. Now we try to establish the taxonomic system of Sphaeroccinae on the basis of revising the data of world and studying our material collected.

This thesis contains three parts: (1) the outline descriptions of known 17 genera and 58 species in the world, of which 6 genera and 9 species were recorded from China. (2) the taxonomic system: we propose 2 tribes (Sphaerococcini Ckll, 1899, Antoninini Borchs, 1949) and 4 subtribes (Sphaerococcina Ckll, 1949, Antonoidina, n. subtrib. , Antoninina Borchs, 1949, Serrolecaniina Shinji 1935). Among which the subtribe Antonoidina is established as new. (3) making a key to all taxa of the subfamily.

MODERN TRENDS IN ORTHOPTERA BIOGEOGRAPHY. M.G.Sergeev (Biological Institute, Siberian Branch, Russian Academy of Sciences, 11, Frunze Str., Novosibirsk 630091 USSR)

Orthoptera is a splendid object for biogeographical investigation. However strange though it may seem, there aren't many papers concerned its biogeography. The main aim of biogeographical investigation consists in elucidation of distribution patterns. The following trends in Orthoptera biogeography may be ascertain:

1. The investigation of taxon distributions through the Earth'surface. The arrangement of the centres of diversity and endemism is usually described, and hypothetical pattern of taxon disperce is suggested.

2. The elucidation of regionalization pattern.

3. The investigation of community distribution.

SYSTEMATICS AND EVOLUTION OF GALL FORMATION IN PACHYPSYLLA (HOMOPTERA: PSYLLOIDEA: SPONDILIASPIDAE). Man-Miao Yang and Charles Mitter (Department of Entomology, University of Maryland, College Park, MD20742, U.S.A.)

Hackberry psyllids Pachypsylla (Hopmoptera: Psylloidea: Spondiliaspidae) is a group of North American gall forming psyllids. They make galls on the different part of hackberry trees, Celtis (Ulmaceae), such as leaves, petioles, buds and twigs. In many cases, although the shape of the leaf galls are very different, the adult morphology is similar. There has long been confusion over how many species are in Pachypsylla. In this paper, morphological as well as allozyme analyses are conducted to answer the question. A phylogeny for Pachypsylla is proposed and the evolution of gall formation is discussed.

AN INVESTIGATION ON THE *EURYGASTER* FAUNA OF IRAN. Morteza Esmaeili, Jafar Mohaghegh, Ebrahim Bagheri Zonoz, Aziz Kharazi and Parvaneh Azmayesh-Fard (Plant Protection Dpt., College of Agriculture of Tehran University, Karaj 31584 Iran)

Four years of investigations on cereal sunn pests of genus *Eurygaster* revealed that at least 3 species of this genus are existed in Iran as follow: *E. maura* (L.), *E. testudinaria* Geophr. Two specimens of *E. austriaca* schore are found in Karaj College of Agriculture museum, but its geographical region is obscure.

FAUNA OF ASTEROLECANIIDAE AND ITS ADAPTATION TO HOST PLANTS AND SPECIATION. Yu-sheng Liu, Yu-liang Shi (Department of Plant Protection, Shandong Agricultural University, Taian, Shandong, China. 271018)

Asterolecaniidae is a smaller group in the superfamily Coccoidea from which the families Lecanodiaspididae and Cerococcidea were divided by Borchsenius (1959) and Koteja(1974),respectively.There are about 250 species of 30 genera included in this family, and 220 species of 23 genera are analysed here.Numerous species of Asterolecaniidae exist in Oriental Region,account for 116 (53% of all species of this family),followed by Palearctic Region,43 (20%), Neotropical Region,32 (14%),Australia Region,19 (9%),Nearctic Region,13 (6%), and Africana Region,11 (4%). All species of the genera Polea Gree (1902), Liuaspis Borchsenius (1960) and Amorphococcus Green (1902) distribute in Oriental Region only; All species of the genera Sclerococcus McKenzie (1958) and Grammococcus Miller et Lambdin(1978) distribute in Neotropical Region only;All species of the genus Frenchia Maskell (1892) distribute in Australia Region only.The host plants of asterolecaniids are more than 40 families.Among them,Pambusa spp. of Gramineae,all species of Fagaceae and Palmaceae are the most important,on which live70,34and22 species,respectively, accounting for126 (55%)of all species studied.Some species and genera parasite on special host plants or special parts of the same plant.This is a prominant habit in the fauna of the scale insects on Fagaceae trees,influencing specieation.

Polyphagism and atypical host association in Indian aphids

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The aphid fauna of rich tropical flora in Indian region (801 species) exhibit a significant trend of polyphagy through a dominance of parthenogenetic generations. Even the host selection mechanism, normally believed to be constrained by presence of secondary substances (Dixon, 1987) show an adaptive trend of tolerance to such substances (Ghosh, 1985). Also an unusually high percentage of endemics (53%) can be explained by a probable process of isolation of race (Van Emden, 1978) from the original species. The occurrence of many aphid species on atypical host plants (Eastop, 1973) in the region, can not however be ascribed to unusual environmental condition. Aphid-plant interaction in Indian region as such provide further insight into the complex mechanism of host selection.

A · MORPHOLOGICAL, SYSTIMATIC AND PHYLOGENY STUDY OF THE FAMILY KERMESIDAE IN CHINA. Hu Xing-ping, Li Shi-zhu (department of Forestry, Shandong Agricultural University,Taian,Shandong 271018,China)

The species of Kermesidae, which are principally found on oak, are now assigned to nine genera at least. The dry and old female, slide-mounted young adult female, adult male and first instar materials collected from thirteen Provinces in China were studied to determine the number of species which acturally exist in China and the relationship among the genera. Five genera one as new record and twenty species five new ones and two new records are described. A new subfamily,Reynaaninae,is proposed.Our work has revealed that the first instars of some different species appear identical in micromorphology, but both their external characters of old females and micromorphology of adult male are evidently different. Some species have two different color forms. the first instar of Reynvaania spinatus has bimorphology. Morphological varieties of the same species, caused by different hosts or geographic distribution, are discussed. The biological habits, host plants, geographical distribution, natural enemies of each species are listed. The phylogenetic relationships of the five Chinese genera of Kermesidae are analysed.

TWO NEW RECORDED APHIDS (HOMOPTERA: APHIDOIDEA: HORMAPHIDAE) FROM CHINA. Charles Chia-chu Tao (Taiwan Agricultural Research Institute, 189 Chung-cheng Road, Wu-feng, 41301, Taichung, Taiwan, China)

Cerataphis freycinetiae van der Goot, 1917 on *Area catechu* Linn. (palmae) and *Tuberaphis loranthi* (van der Goot, 1917) on *Scurrala liquidambariclous* (Hay.) (Loranthaceae) are first recorded from Taiwan, China with key to species of each genus, characters of each species of apterous viviparous female and new morph of alate viviparous female of *C. freycinetiae* are figured and described respectively.

ALLOZYME ELECTROPHORESIS AND THE RECOGNITION OF APHID SPECIES. Dinah F. Hales (School of Biological Sciences, Macquarie University, N.S.W. 2109, Australia).

It is often difficult to decide whether two morphologically similar species of aphids belong to the same or to different species. Allozyme electrophoresis offers a quick and relatively inexpensive means of collecting data that may enable a correct decision to be made. The criteria for decision will depend on whether the populations are functionally sympatric (i.e. are holocyclic with sexual forms coexisting in space and time) or functionally allopatric (i.e. continuously parthenogenetic, allopatric, or having sexual forms which do not occur synchronously). Functionally sympatric populations can be identified as separate species if 1-2 fixed gene differences are present, provided the number of clones tested of each suspected species is >6. Functionally allopatric populations can be assumed to belong to different species if the fixed gene differences exceed 20%. If neither of these genetic criteria is fulfilled, a decision must be based on morphological or biological data. Allozyme data can furthermore provide simple tests for the positive identification of similar species of aphids or other organisms.

HENRY WALTER BATES AND THE ADEPHAGAN COLEOPTERA.
George E. Ball (Department of Entomology, University of Alberta, Edmonton, Alberta, Canada T6G 2E3)

A major contributor in the latter half of the 19th Century to knowledge of cicindelid and carabid beetles, Henry Walter Bates provided principally faunistic treatments of genera and species. His contributions are distinguished by perceptiveness, clarity and simplicity of expression, and by the many valuable comments that they contain about species relationships, and as well, ecological associations for the species that he knew from field experience. His work will be reviewed in the context of the time in which he lived, and in the context of 20th Century systematic entomology.

OUTLINES OF ECOLOGICAL ZONATION IN GONDWANALAND BASED ON THE DISTRIBUTION OF EXTANT COLEOPTERA. Sebastian Endrody-Younga (Transvaal Museum, P.O. Box 413, Pretoria 0001, Rep. South Africa).

When studying groups of southern African Coleoptera, it often happens that they cannot be derived from the fauna north of the subcontinent. Others are altogether isolated in the south. This is mostly the case with primitive families and the primitive stocks of larger groups. Intensive collecting on the southern continents, and ongoing comparative studies, reveal the existence of a Gondwana -time relic in the faunas of Australia, South Africa and South America. Such relic taxa are often represented on two of the continents in different combinations.

Comparing the preferred habitats of intercontinentally linked taxa, striking similarities can be found. A selection from the available data will demonstrate that present-day distributions may provide a means whereby the climatic zonation of Gondwanaland, at the time of the continental breakup, might be reconstructed.

PHYLOGENETIC IMPLICATIONS OF LARVAL MORPHOLOGY IN THE TRIBE OZAENINI (COLEOPTERA: CARABIDAE). Augusto Vigna Taglianti, Fabrizio Santarelli (Department of Animal and Human Biology, University of Rome "La Sapienza", Viale dell'Universita, 32 - I 00185 Roma, Italy)

The morphology of the larval stage of the Carabid beetles of the tribe Ozaenini is known only in two nearctic species: a myrmecophilous species (*Physea setosa* Chaudoir) and an unidentified species with unknown biology. Both larvae are characterized by the 8th and 9th abdominal segments, transformed in a plate (abdominal disk). The same peculiar feature is present in the larvae of myrmecophilous and termitophilous Carabid species of the tribe Paussini, and has been related with the myrmecophily. In this work the free living larvae of the cave dwelling species *Pachyteles urrutiai* Bolivar from Mexico and *Pseudozaena cavicola* Moore from Papua New Guinea, are described. The morphology of the last abdominal segments is quite similar to the myrmecophilous species, and obviously not related to the myrmecophily. The phylogenetic relationships between the tribes paussini, Ozaenini, and Metriini are discussed.

ROLE OF EXTERNAL GENITALIA IN THE TAXONOMY OF SUB-FAMILY BRACHYDERINAE (CURCULIONIDAE:COLEOPTERA).
S.S.Gandhi & H.R.Pajni(Department of Zoology, Panjab University, Chandigarh, India.

A study of male and female genitalia in 99 sps. of Brachyderinae reveals that the shape of aedeagus, length of aedeagal and phallobasic apodemes, type of endophallic armature, presence or absence of styles and the length of ovipositor show variation at the level of different taxa. The subfamily is distinct in having styles on the apices of the coxites. At the tribal level, the tribes Blosyrini and Dermatodini are free from any parameral processes. The former also has rounded or subtruncate aedeagus and complex endophallic armature. The tribe Dermatodini possesses unusually long aedeagal apodemes, short and typically shaped aedeagus and a hook-shaped rod on the endophallus. Under the tribe Tanymecini, the subtribes Piazomiina and Tanymecina can be divided each into 2 categories on the basis of attachment of aedeagal apodemes and length of ovipositor. Several genera show a constant type of male genitalia characteristic of each. The subgenera under a few of them can also be differentiated from their special structure of ovipositor. The Fauna under the remaining four tribes has species-specific differences in the male genitalia.

REVIEW OF THE HIGHER CLASSIFICATION OF THE CURCULIONIDAE ADELOGNATHI (COLEOPTERA:CURCULIONOIDEA). Katsura Morimoto (Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, 812 Japan)

Present review is based on the recent data on the adult and larval characters of the " exceptional taxa" of the Adelognatha inhabiting in Japan. The Pachyrhynchinae and Sitoninae are recognized as independent branches on the way to the Otiorhynchinae from the primitive stock. The Desmidophorinae are inferred as a primitive subfamily in the Adelognatha analogous to the case of the Brachycerinae and Alophinae. The problematical genus Euphyllobiomorphus contains one species, which is so similar to a species of Phyllobius that Sawada(1987) treated the former as a subgenus of the latter. This is the only genus that has an anthonomine-like rostrum in the Adelognatha somewhat like the case of two exceptional genera, Auchmeresthes and Metacinops from Greek.

HISTORICAL ECOLOGY OF SUBANTARCTIC WEEVILS: PATTERNS AND PROCESSES ON ISOLATED ISLANDS. S.L. Chown (Department of Entomology, University of Pretoria, Pretoria 0002, South Africa)

The South Indian Ocean Province (SIP) Islands are unique both biologically and due to their extreme geographic isolation. As such they provide an ideal independent testing ground for current hypotheses in ecological and evolutionary biology. Diverse, monophyletic taxa are most useful for such investigations and the *Ectemnorhinus*-group of weevils is the only taxon in the SIP which satisfies these criteria. Here, the sum of knowledge concerning the group is reviewed and compared with current ecological and evolutionary theory derived mostly from studies of the faunas of tropical and/or less isolated islands. Three major habitat shifts, one involving a habitat reversal, are associated with a minimum of nine cladogenetic events in the evolution of the *Ectemnorhinus*-group. These shifts appear to have been driven by climatic change and the establishment of new selective regimes in the sub-Antarctic. Habitat constancy seems to be the norm for this taxon, and habitat shifts take place as a result of climatic forcing rather than persistent interspecific competition. In the old, epilithic biotope, however, interspecific competition may be an important cause of assemblage structure on at least some of the SIP islands. Although speciation within the *Ectemnorhinus*-group appears to have been via the allopatric mode, associated with inter-island and inter-archipelago movement, the current habitat reversal, i.e. from cryptogam herbivory to angiosperm feeding, is characterized by sympatric speciation in the genus *Ectemnorhinus* on Marion Island. The ecological and evolutionary patterns shown by the ectemnorhinines are scale-dependent, and not remarkably different from those recorded in other diverse, island taxa.

BIONOMICS AND MORPHOLOGY OF THE LARVAE OF *AMPHIZOA SINICA* Yu et Stork Pei-yu Yu, Wei-ping Xie (Institute of Zoology, Academia Sinica, Beijing 100080, China), Feng-qin Lin (Bureau of Changbai Mountain Natural Reserve, Jilin Province 133613, China)

This paper reports for the first time on the bionomics and morphology of the larvae of Amphizoidae. The larvae of *Amphizoa sinica* habitat in the cold swift-flowing current of the Second White River, in the conifer and deciduous mixed forest zone about 740 meter altitude in the Changbai mountain region. These larvae are most often found wherever masses of drift gathered, especially in the submerged fallen branches, leaves, barks etc. which are piled by the fallen trunk and logs, at the edge of the winding river, or on other floating debris in backwater eddies. The larvae are fond of semienclosed niches. They mainly feed on insects and their dead bodies. They have three larvae instars. The first instar lasts for a long time, about 9-10 months (from July-August till April-May of the next year) and passes winter; the second and third instars last about one month each. In general, they move by crawling on the piled debris or on the floating drifts; or by drifting up side down in the water, moving by twisting and flapping their bodies and keeping the 8th pair of spiracles above the water surface. The larvae are always gregarious. They can survive by having sematic color and mimic tree buds, pine seeds or leaflets of *Sorbaria*. Besides, they are able to feign death. They used to be hidden and remain motionless, but become violent when disturbed. The morphology (SEM) of the head and the 8th pair of dorsal spiracles, etc. are studied.

MORDELLIDAE, SCRAPTIIDAE, RHIPIPHORIDAE (COL.HETEROMERA) OF CHINA, TODAY. Mario E. Franciscolo (Honorary Fellow, Società Entomologica Italiana, Via Brigata Liguria 9, 16121, Genova, Italia).

The first Chinese Mordellid was described by Pic in 1924; 21 species are known from China, almost all from Fukien from Klapperich's 1946 catches; Scraptiids have 2 species; Rhipiphorids, reviewed by Gressitt in 1941, have 12 (a 13th one was added by Pic in 1949).

Taiwan has in all 75 species, Laos and Vietnam 65, Japan 125, Mongolia 55; the species diversities of nearby regions visited by me suggest that China should have more than 300 species (most undescribed), a few ones perhaps shared with other Asian regions. Nothing we know about the bearing these Families offer to the biogeographical interpretation of the Chinese transition zones; the unrealistically few known species show a vague affinity with S.E. Asian fauna only.

I offer my cooperation and suggestions to any Chinese Entomologists willing to start intensive collecting and to review monographically the Chinese species of these Families which (Mordellids in particular) are relevant components of forest insect fauna as shown by Hammond in 1990 for Sulawesi Utara. Many species are also important pollinators.

A TAXONOMIC STUDY OF THE CHINESE ELATERIDAE (COLEOPTERA). Shi-hong Jiang (Department of Plant Protection, Huazhong Agricultural University, Wuhan 430070, China)

The species of Elateridae is very rich in China, but little taxonomic study was done formerly. Liu (1932) and Wu(1937) only recorded 174 species of the Chinese Elateridae. Since 1985, I has collected a large amount of the taxonomic literature and a lot of the click-beetle specimens from many districts of China. Through identification and the taxonomic study to them, the number is increased by over 420 species, which are divided to 91 genera, 10 subfamilies: Oxynopterinae 19 spp., Hypnoidinae 16 spp., Pytiobiinae 5 spp., Pyropnorinae 86 spp., Denticollinae 82 spp., Elaterinae 123 spp., Oestodinae 8 spp., Cardiopnorinae 35 spp., Melanotinae 44 spp., Negastriinae 8 spp.. More than 200 species are redescribed, and several new species and new record from the Chinese fauna are given. The keys to the subfamilies, tribes, genera and species of the Chinese Elateridae are provided. The geographic distribution of the Chinese Elateridae is also analysed preliminarily. Now I am going to identificate the other click-beetle specimens. I am sure that the study will make the species number of the Chinese Elateridae increase greatly.

CLADISTIC ANALYSES OF THE COCCINELLIDAE(COLEOPTERA). Guo-yue Yu, Xiong-fei Pang(Lab. of Insect Ecology, South China Agricultural University, Guangzhou, 510642, China)

Numerical cladistic method was used for analyzing the phylogeny of ladybirds, based upon adult and larval characters. The analysis of adult characters for 21 tribes, representing all subfamilies proposed by various authors, exhibited 18 equally parsimonious cladograms and high level of homoplasy. Five lineages were showed in the strict consensus tree: Sticholotidinae, Epilachninae, Coccinellinae(including Singhikalini), Coccidulinae(excluding Noviini) and Scyminae+chilocorinae. The taxonomic interpretation of the adult analysis was similar to the classification proposed by Chazeau *et al.*(1990). Comparison of a preliminary analysis based on the larval characters for 14 tribes revealed only one component consistently supported in both analyses(Serangiini+Sukunahikonini), and the resulting cladograms more resembled the cladograms based on adult characters alone than ones on larval characters when adult and larval characters were combined in a single data matrix.

Epilachinae is the most primitive and highly derived group of the Coccinellidae. Higher classifications of the family are heavily based upon adult characters, and larval classifications might be more satisfactory in revealing the phylogeny.

A STUDY ON THE CLASSIFICATION OF THE GENUS MELANESTHES LACORD. IN CHINA (TENEBRIONIDAE: APATRINI). Guo-dong Ren (Institute of Pests and Plant Disease Management, Ningxia Agricultural College, Yongning, Ningxia 750105, China)

The genus Melanesthes Lacord 1859 belongs to the tribe Opatrini, the family Tenedrionidae. There have been 36 species in the world which distributed in the desert and semi-desert of central and east Asia. There had been 12 species recorded in China which belong to 5 subgenus. Through the collecting and studying of the specimens in Ningxia, the Inner Mongolia, and Gansu province, 3 new records and 7 new species have been found, so that the number of the species distributed in China have reached 22. The name, distribution and the key of these species are described and presented in the paper.

CATALOGUE OF PALAEARCTIC DIPTERA: A LARGE PROJECT TO BE ACCOMPLISHED. A.Soós (deceased) and L. Papp (Hungarian Natural History Museum, Budapest, H-1088 Hungary.

The CPD was initiated by Hungarian workers at the 7th Symposium of the SIEEC held on 19-24 Sept 1977 in Leningrad (more than half of the subsequent authors attended). Contrarily to the initial problems with the publication and the formal requirements, the fact that the efforts of the Board of Editors to locate the best specialists as authors met with a number of difficulties and there was lack of funding and technical staff, Vols 9 and 10 were published on 15 Oct 1984; they were followed at irregular intervals by the other ones, until we arrived, in 1991, to the completion of the MS of Vol. 1, the last in the order of publication (Vol. 14, comprising the cumulative indices will shortly be finished). The CPD contains the basic taxonomic, nomenclatorial and distributional data of all species described or known from the Pal. Reg. (nearly 30,000 spp.), besides the fundamental morphological features of the majority of fly groups. The period of the CPD extends from 1758 to 31 Dec 1982. The CPD was published by the Akadémiai Kiadó Budapest and the Elsevier Sci. Publishers Amsterdam (though the publication of Vol. 13 was suspended in 1991), the last two volumes, Vol. 1 and Vol. 14 by the Hungarian Natural History Museum.

The editors are indebted to all fellow authors who undertook the uncongenial task of writing several chapters of the CPD. Conditions are now ripe for the preparation of the World Catalog of Diptera.

SYSTEMATICS AND EVOLUTION OF THE SOUTH AMERICAN BEE GENUS CALLONYCHIUM (HYMENOPTERA, APOIDEA). Luisa Ruz (Department of Zoology, Catholic University of Valparaiso, Chile).

Callonychium, a monophyletic genus, includes small-sized individuals and the most derived species among the Calliopsini (Panurginae, Andrenidae) (Ruz, 1991). A study of morphological traits of adult individuals and a cladistic analysis showing the phylogenetic relationships among 11 known species and 10 new ones is here conducted and discussed. The main and most striking apomorphies are exhibited by metasomal sterna and pygidial plate of males. The majority of the species present a similar appearance; however, it is easy to separate them with a key for identification using the main following characters: width of head versus length, yellow pattern of body, size and shape of sternal protuberances and type of bifurcation of pygidial plate on male metasoma, patch of hairs on sternum 4th of females. The geographic distribution of this genus presents an interesting pattern at the level of some groups of species in southern South America.

THE PHYLOGENETIC POSITION OF THE ONYCHOPHORA AS SUGGESTED BY 12s rRNA SEQUENCES. J.W.O. Ballard (CSIRO, Divsion of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia), G.J. Olsen (Department of Microbiology, University of Illinois, Urbana, Illinois 61801, USA), D. Rowell (Department of Botany and Zoology, ANU, ACT 2601, Australia), B. Richardson (University of Western Sydney, Bourke Street, Richmond, NSW 2753, Australia), W. Odgers (CSIRO, Division of Entomology) and P.W. Atkinson (CSIRO, Division of Entomology).

The Onychophora are a 'primitive' taxa whose phylogenetic position has generated considerable debate. We have used two primer sets to amplify and sequence 12s rRNA from a wide variety of organisms including Molluscs, Annelids, Chelicerates, Crustaceans, Myriapods, Hexapods and Onychophorans.

In this seminar we will discuss the difficulties of aligning highly divergent sequences and problems concommitent with the analysis. We will compare the morphological and molecular data and conclude by considering the phylogenetic utility of 12s rRNA.

SYSTEMATIC STUDIES ON APHELINIDAE (HYMENOPTERA: CHALCIDOIDEA) OF CHINA. Huang Jian (Department of Plant Protection, Fujian Agricultural College, Fuzhou, Fujian 350002, China)

Based upon studies of about 10 thousand aphelinid specimens collected mainly from Fujian Province of south China, the present paper describes 93 species and 17 genera of Aphelinidae, including 42 new species, 1 new combination species, and 4 genera and 14 species which are recorded for the first time from China. The materials on which this study is based are housed in Fujian Agricultural College, Fujian, China.

In the general account of this paper, the historical review, current taxonomic notes, morphology and biology of Aphelinidae are dealt with. Keys are given to Chinese genera of Aphelinidae and to species of some genera treated in the taxonomic part. Under each genus, generic synonymy, diagnostic characters, phylogenetic relationship, systematic history and present systematic status are reviewed and discussed. The species which are new to science and new to China are described, and all species treated in the paper are illustrated in detail.

PATTERN AND PROCESS IN SPECIATION: A COMPARATIVE APPROACH USING A HAWAIIAN SPIDER RADIATION. Rosemary G. Gillespie (Hawaiian Evolutionary Biology Program, 3050 Maile Way, Gilmore 310, University of Hawaii at Manoa, Honolulu, HI 96822)

Speciation is fundamental to evolutionary biology, yet the processes involved remain enigmatic. At the basis of the problem is the necessarily heavy reliance on inference, as it is rarely possible to find systems which are amenable to both generating and testing phylogenetic hypotheses. I have recently discovered a large species radiation of spiders of the genus *Tetragnatha* in the Hawaiian islands in which: (1) Preliminary phylogenetic analysis, using both morphological and molecular information, has allowed me to generate hypotheses regarding the mechanism of speciation within a clade. (2) Amenability to ecological and behavioral analysis presents an opportunity to test these hypotheses. (3) Contrasts provided by different groups within the lineage allow determination of the interaction between ecological affinities and species formation. In particular, groups differ in terms of habitat specialization, allowing comparative analysis to test theories as to the interaction of habitat specialization and mechanism of speciation. I am using the system to address two primary questions: (1) Are the characters responsible for initiating divergence among populations ecological or sexual in nature? To address this question I use a detailed systematic analysis of a small clade, coupled with ecological and behavioral observations and manipulations to determine changes that occur during the formation of species. (2) Among this spider lineage, do habitat specialist groups differ from habitat generalists in their biogeographic pattern of phylogeny ? Current theory would predict that habitat specialists may be capable of parapatric speciation through the operation of disruptive selection, while habitat generalists require strict allopatry. I test the prediction that habitat specialist groups can speciate on one volcano of the Hawaiian islands, while generalists can only speciate on different volcanoes.

#1

RARITY AND SPECIES RICHNESS AS MEASURES OF BIODIVERSITY. Rauno Vaisanen (Water and Environment Research Institute, P.O. Box 250, SF-00101 Helsinki, Finland), Kari Heliovaara (Finnish Forest Research Institute, P.O. Box 18, SF-01301 Vantaa, Finland)

The presence/absence data derived from 70 x 70 km quadrates or provinces were used in calculating rarity and species richness indices for five insects groups in northern Europe. Samples with the most deviant indices for the species assemblages were concentrated in several sites in southern Scandinavia, some sites in northern Sweden, and especially on the islands in the Baltic Sea. Simple rarity indices emphasized areas near the capitals, where the faunas are well-known due to high collecting activity. More realistic picture of the actual biodiversity were revealed by using more effective indices, which also take into account the number of recorded species. The high faunal diversity in national parks and strict nature reserves are seen in the respective indices. The simultaneous use of several indices gives one possibility to evaluate local nature conservation values associated with biological diversity.

#2

AUSTRALIAN BIOLOGICAL RESOURCES STUDY
Keith Houston,
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The *Australian Biological Resources Study* provides a national focus for the documentation of biodiversity. Its main aim is to document the flora and fauna of Australia and to determine their distribution.

ABRS supports research on the flora and fauna and maintains a register of taxonomists, biogeographers and biological illustrators.

ABRS publications include:

Zoological Catalogue of Australia (approx. 90 volumes): A comprehensive bibliographic and computer based source of available taxonomic and biological information for each species of the fauna.

Fauna of Australia (10 volumes): A comprehensive account of the current knowledge of the morphology, physiology, natural history, biogeography and phylogeny of the animals which live in Australia.

Flora of Australia (approx. 60 volumes): Descriptions of and keys to all native and naturalised plants found in Australia.

#3

NUMERIC-CODED SYSTEM OF SPECIMEN INSECT MANAGEMENT. Hua-zao Sun (Central-south Forestry College,Zhuzhou,Hunan 412006,China)

The Numeric-coded System of Specimen Insect Management is a reference book devoted to the modernized handling of insect specimens. Inclusive of all China's known insects by species in 20000 genera of 886 families from 34 orders, the book provides the prospective reader with certain numeric codes for the considered insect names; thus digitization is realized.The book falls into three parts. Part one deals with the systems codes, the Latin names and the Chinese names. Part two is the Latin-Chinese-code arrangement. Part three appears in Chinese-Latin-code form at the level of subfamily and above. With proper computer software part one can be developed into a computerized system of management. It can help manipulate the entire reported insect species as the data is added. The book is of great value for the large or medium-sized specimen center or museum to base its specimen management and/or its computerized insect data bank. Those in a small insect room and the other entomologists will also find the book helpful when they need to look up an insect name and the classification standing of the insect,to arrange the inventory data and to compile a systematic classification list.

#4

GLYCOSIDASE AND FOOD HABIT IN INSECTS FROM THE POINT OF VIEW OF CHEMOTAXONOMY. KOIKE,Hisayoshi and Seiroku SAKAI(Institute of Biology & Life Sciences,Daito Bunka University,560,Iwadono,Higashi-Matsuyama,Saitama,Japan 355)

Anisolabis maritima,Callosobruchus chinensis,Pieris rapae and *Vanessa indica* were used for the present study.

Food habit is interest phenomena in evolution and comparative biochemistry. Insect food habit is mainly classified in omninvora and phytophagy.Omnivora may be original food and,in contrary,phytophagy in Lepidoptera is derived from omnivora in the tertiary era.

Isozyme analyses were conducted in relation to comparative biochemistry.

Each of Substrates used was sucrose,trehalose,soluble starch and inulin,respectively.

In omninivorous species,trehalase activities were higher than invertase activities but the reverse was the case in phytophagous species.

Higher inulinase was revealed in Lepidopterous insects because of glucofructosidase.

Furthermore,lower molecular weight isozymes of polyases were characteristic feature.

Dermapteran insect used was recognized the peak of middle molecular weight isozymes.

#5

A TYPICAL HIGH-COLD REGION INSECT FAUNA. Fusheng Huang, Xuezhong Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Hoh Xil region is located in 33°20'-36°N, 89° 20'-90°E. It lies to the north of Qinghai-Xizang plateau. It is the center region of this plateau and is known as "Qiang-Tang plateau" or"no habitant region". Its average altitude is 5000m. Many conditions exert strong influence on the insect fauna and make it a typical high-cold region insect fauna, such as high altitude, low temperature, a few rianfall, strong wind and sparse vegetation. The characters of this fauna could be as follows.

1. The constitution of fauna shows the simplicity of species. But many species possess numerous population.

2. The endemic species are absolutely predominant and amount to 62.3% in the whole insect fauna.

3. The palearctic element shows an important role and make up 31.9% in the insect fauna. The wide-distribution species are much fewer. There is none oriental species.

4. The aquatic insect living in lakes occupy an excellent proportion.

5. The insects active on ground are abundant.

#6

FAUNA OF EXOTIC INSECTS IN JAPAN. N. Morimoto (Division of Entomology, National Institute of Agro-Environmental Sciences, Kannondai 3-1-1, Tsukuba, Ibaraki, 305 Japan), K. Kiritani (Food and Fertilizer Technology Center, 5th Fl. 14 Wenchow St., Taipei, Taiwan, China)

The number of exotic insects in Japan is increasing steadily, due to recent active international trades. To study exotic insects is not only interesting from view points of biological invasion and biogeography but also necessary for pest management. However, no detailed list has been reported in Asia. In this study, we report fauna compositions of exotic insects in Japan.

Among about 20,000 insect species in Japan 198 species were considered to be exotic insects, including intentionally introduced 11 species. The numbers of exotic insects in Homoptera, Coleoptera, Lepidotera, and Hymenoptera were 58, 61, 22, and 19, respectively. The number of exotic insects from these orders corresponded to 86% of the total number of exotic insects. In terms of the proportion of exotic to all insect species in each order, those in Coleoptera, Lepidoptera and Hymenoptera were less than 0.7% but that in Homoptera was 6%. The proportions in other orders, Isoptera, Blattaria, Thysanoptera, and Anoplura, were over 5%. Seventy two percent of exotic insects were regarded as a pest, while only 7% of native insects were pest species.

#7

COMPARATIVE SPERMATOLOGY OF BLATTARIA. A.G. Burrini, B. Baccetti, G. Collodel (Inst. of General Biology of the University, and Center for the Study of Germinal Cells, C.N.R., Siena, Italy), I. Huber (Dept. of Biology, Fairleigh Dickinson Univ., Madison, N.J., U.S.A.)

Extremely poor information is available concerning Blattaria spermatozoa, summarized by Baccetti (1987) and Jamieson (1987), in comparison with the large amount of interesting data concerning most of the other insect orders. In this paper we report observations concerning about 30 blattarian species, belonging to the families Cryptocercidae, Blattidae, Blattellidae, Blaberidae (Blaberoid, Panchloroid and Epilamproid complexes). The general features of the blattarian spermatozoon are quite homogeneous: a cylindrical nucleus is capped by a conical acrosome containing a fibrous perforatorium; two almost completely crystallized mitochondrial derivatives flank a "9+9+2" axoneme, a compact centriolar adjunct holds the base of axoneme and mitochondria. Variations occur only in the nuclear and mitochondrial shape, in the organization of the acrosome and in the length of head and tail. The most classical orthopteroid model is that of Cryptocercus, whose acrosomal complex is made up of two juxtaposed cones, while Blaberidae have mostly an anteriorly opened cylindrical acrosome and Blattidae bear a membranous conical cup in front of the acrosome. The length is maximal in Cryptocercus, minimal in Blattidae. Blattidae have in cross section a circular nuclear shape, while this perimeter bears one lateral indentation in Cryptocercus, Blattellidae 2 and Blaberidae from 2 of Blaberus to 4 of Thanatophyllum. In conclusion Blattaria appear a real single order, placed at the base of the Orthopteroid complex and slightly evolved through the various existing families.

#8

TRICHOPTERA, RPHEMEROPTERA AND PLECOPTERA OF THE RAZDOLNAJA RIVER (SOUTH PRIMORYE, RUSSIA), Tatyana S. Vshivkova, Tatyana M.Tiunova, Valentina A.Teslenko (Inst. of Biology and pedology, Far east Branch of Russian Acad.of Sciences, Vladivostok 690022, Russia)

The Razdolnaja River (Suifen Ho) is the main river of South Primorye. The upper part of this river, located on China territory, but plain part-in Russia. Length of river -245 km (the lower 191 km located in Russia).

Investigation of aquatic insects of Razdolnaja River was started in 1989. 25 stations were established from Chinese boundary to the mouth. Insects were collected from October 1989 to September 1991during 3 seasons. As result we found 27 Trichoptera species, 33-Ephemeroptera,21-Plecoptera. Trichoptera consist of 10 families: Hydroptilidae(1), Psychomyiidae(2),Hydropsychidae(7), Stenopsychidae(2) Limnephilidae (2) , Goeridae (1) , Molannidae (1) , Leptoceridae(9); 1 species of Rhyacophilidae and 1-Glossosomatidae were caught by light-trap.Ephemeroptera contains10 families:Potamanthidae(2),Ephemeridae(2), Polymitarcyidae(1),Heptageniidae(10),Siphlonuridae(1), Baetidae (5), Oligoneureidae (1), Leptophlebiidae(1), Ephemerellidae(10),Caenidae(1). Plecoptera contains 7 families:Pteronarcyidae(1),Perlodidae(8),Perlidae(3) Chloroperlidae(5),Taeniopterygidae(1), Leuctridae (1) Capniidae(1). Some species of caddisflies, 1-mayflies and 2-stoneflies are new to science.

#9

CLADISTIC ANALYSIS OF PHENOTYPIC AND ALLOZYME DATA OF KOREAN ENTOMOBRYID COLLEMBOLA (INSECTA). Byung-Hoon Lee , Kyung-Hwa Park (Department of Biology Education, Jeonbug National University, Deogjin-dong, Jeonju, 560-756 Republic of Korea.)

In order to elucidate phylogenetic relationship of Korean Entomobryidae morphological as well as allozyme data were analyzed using UPGMA and a few recent versions of phylogenetic programs. Seven species in four genera including nine populations were examined for 32 morphological and 33 chaetotaxical characters in addition to 80 genetic data obtained experimentally.

The results showed varying cladograms depending on types of characters and programs employed.

Homidia species were found to fall into two clusters and two subspecies of Homidia munda remained most closeby each other, whereas two different populations of Homidia koreana made it dubious of their conspecificity by showing more or less separated positions. The peculiar location of Tomocerus, in addition, between entomobryid genera remained to be studied.

Generally the conventional taxonomy of the group was supported while the study uncovered apparently a few problematic issues which, otherwise, would have been ignored.

#10

STUDY ON THE KIND AND DISTRIBUTION OF THE INDOOR COCKROACH IN CHINA. Ping-zhang Feng (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing, China)

This paper reports the result that author investigated the cockroach pest occurred indoor in China from 1982 to 1991. We collected 24 species and 2843 individual in all, which were subordinated to 13 genera of 6 families, The key of 24 species is given, 1 new record, Nauphoeta cinerea(olivier), from China and 1 new record, Periplaneta karnyi (Shir.), from the continent of China are described. This paper deals with the distribution and their occurrence indoor in China: 1. Nine species distributed throughout China and constituted 37.5% of the totao indoor cockroach. Among them, 1 species, Blatlella germanica (L.) was the dominant species of the whole nation, 2 species, Periplaneta americana (L.) and Periplaneta fuliginosa Serv., were the dominant species in the south of China and Yangtse River Valley, 2 species, Periplaneta japonica Karny and Parcoblatta kyotensis Asahina, were dominant species in the north of China i.e. Liaoning province. 2. Two species, Blatta orientalis L. and Polyphage plancyi Bolivar, were the northern species and constituted 8.3% of the total indoor cockroach, the former was found to distribute in Xinjiang province and Beijing, the latter spread from north to south for fooding as medicine by the southern famer from the mid 1970's to the early 1980's. 3. One species, Eupolyphaga thibetana Chop., was only found in Tibet Region and constituted 4.2% of the total indoor cockroach. 4. There were 12 species to distribute in the south of China and constituted 50% of the total indoor cockroach. Among them, 4 species, Neostylopyga rhombifolia (Stoll), Periplaneta australasiae(Fab.) Episymploce sinensis (Walk.) and Episymploce malaisei malaisei(princis), were domi- species in the River valley, the seaboard and the higher temperature and humid region.

#11

THE PRESENT STATUS OF TERMITE TAXONOMY IN JAPAN. YOKO TAKEMATSU (ENTOMOLOGICAL LABORATORY, FACULTY OF AGRICULTURE, KYUSHU UNIVERSITY, FUKUOKA 812, JAPAN)

The present status of the taxonomy of termites in Japan is reviewed. Japanese termites are summarized as in Table. The known living termites comprise 4 families, 10 genera, and 16 species.

The current taxonomy of termites in Japan is far from complete. In paticular, the following issues remain to be resolved: (1) distribution and geographic variation; (2) relationship between Japanese fauna and Asian continental one; (3) taxonomic position of infraspecific level.

These problems are discussed on the basis of a new study.

Table. Termites in Japan

family Kalotermitidae	family Rhinotermitidae
Neotermes (1sp.)	*Reticulitermes* (3spp.)
Cryptotermes (1sp.)	*Coptotermes* (1sp.)
Gryptotermes (5spp.)	family Termitidae
Incisitermes (1sp.)	*Odontotermes* (1sp.)
family Termopsidae	*Nustitermes* (1sp.)
Hodotermopsis (1sp.)	*Pericapritermes* (1sp.)

#12

SYSTEMATIC STUDIES ON THE GENUS MEGACRANIA KAUP, 1871 (CHELEUTOPTERA: PHASMATIDAE). Chia-Chi Hsiung (Lyman Entomological Museum & Research Laboratory, Macdonald Campus, McGill University, 21111 Lakeshore Road, Ste. Anne de Bellevue, Quebec, Canada H9X 1C0)

The genus Megacrania Kaup, 1871, type species M. phelaus (Westwood, 1859), includes six known species which are mostly distributed along the western Pacific Ocean from the north-east of Australia to New Guinea, the Solomon Islands, Indonesia, the Philippines, extending to Micronesia and southern coast of Taiwan.

A key to the known species of Megacrania is presented. Morphological studies and geographical distribution are discussed.

#13

DESCRIPTION OF THREE NEW SPECIES OF THE GENUS PIELOMASTAX CHANG FROM CHINA (ORTHOPTERA: EUMASTACOIDEA). Yu-wen Wang (Department of Biology, Shandong University,Jinan, Shandong,250100, China)

Three new species of the Pielomastax Chang 1937 are described. The type specimens are deposited in the Department of Biology, Shandong University.

Pielomastax lobata sp. nov.

The new species is similar to P. cylindrocerca Hsia et Liu, but differ in the shape of subgenital plate in female.

Pielomastax tridentata sp. nov.

The new species is similar to P. tenuicerca Hsia et Liu, but differ from ventral valvulae of the ovipositor with 3 large pegs.

Pielomastax shennongjiaensis sp. nov.

The new species is related to P. tenuicerca Hsia et Liu, But differ from the shape of subgenital plate in female.

#14

SYSTEMATICS AND ACOUSTIC BEHAVIOR OF THE GENUS *LOXOBLEMMUS* (ORTHOPTERA: GRYLLIDAE) FROM TAIWAN. Jeng-Tze Yang (Department of Entomology, National Chung Hsing University, 402 Taichung, Taiwan, China).

This paper deals with nine species of crickets of the genus *Loxoblemmus* Saussure from Taiwan. In addition to the classical morphological characters, the characteristics of the acoustic behavior were also included in this study. The calling sound of these species were recorded in laboratory and analyzed using digital sonagraph (Kay 7800 and Kay 5500) and signal analyzer (Brüel & Kjaer 2033). The acoustic characteristics used as taxonomic characters including the temporal character, such as duration of a chirp and of a pulse, interval between chirps, pulse numbers per chirp, and the frequency charater, such as dominant frequencies, power spectra and frequency range.

This genus possessed acoustic characters of frequency ranging from 3.5 to 5.7 KHz, and the low and high ranges of the duration of a chirp, respectively from 24 to 56 msec and 32 to 63 msec. This genus in general had 2 pulses per chirp except *Loxoblemmus arietulus* and *L. neoarietulus* n. sp., which had 6 pulses per chirp.

#15

REVISIONAL COMMENTS ON THE CLASSIFICATION OF DERMAPTERA. SAKAI,Seiroku(Institute of Biology & Life Sciences,Daito Bunka University,Nr.2-26-12,Sendagi,Bunkyo,Tokyo, Japan 113)

Sakai(1970-1991:Dermapterorum Catalogus:I-XXIII,7,886 pp) compiled much of the relevant taxonomic information and references on Worldwide valid and invalid Dermapteran taxa since Linnaeus(1758).However,the citations of Steinmann's Catalogue(1989) and Das Tierreich(1986,1989) on Dermapteran species have sometimes overlooked important taxonomic references.The suprageneric names as subfamily level by Steinmann(1989) are incorrect: [Carcinophoridae] for Anisolabididae;[Labiidae] for Spongiphoridae;Correct names:Brachylabidinae,Isolabidinae,Antisolabidinae,Gonolabidinae,Parisolabidinae,and Idolopsalidinae.Many incorrect synonyms are cited in Steinmann's World Catalogue and Das Tierreich as Sakai(1990) has pointed out.Steinmann's Catalogue and Das Tierreich are useful but have several different approaches from Sakai's Catalogus and other references.A new genus,*Paralabella*,erected by Steinmann(1989)on the basis of paramere shape of the male genitalia is a sample of the excellent treatment of Dermapteran classification by Steinmann(1989).

However,Genitalatinae cited by Steinmann(1989) is incorrect, and *Genitalata mahajani* Kapoor(1974) is a correct synonym of *Forcipula quadrispinosa* (Nymphal stage) by Srivastava(1986). *Genitalatinae* should thus be eliminated.Some species complex including *Euborellia,Anisolabis,Labidura,Anechura* and *Forficula* are considered with respect to individual variation and so on.

#16

MORPHOROGICAL VARIATION ON *ANECHURA HARMANDI* (BURR), FORFICURIDAE, DERMAPTERA:GEOGRAPHICAL VARIATION IN THE FREQUENCY OF FORMA *HARMANDI* AND *LEWISI*. TERATA, Kohji and Seiroku SAKAI (Institute of Biology & Life Sciences, Daito Bunka University, 560 Iwadono, Higashimatsuyama, Saitama, Japan;355)

Except for forma *soedaensis* in the Kyushu Island, there were *lewisi*-monomorphic populations in the Chugoku district, the south Honshu of the Main Island of Japan and the end of the Tohoku, the north Honshu, and there were polymorphic populations of *harmandi* and *lewisi* in the other areas. In every polymorphic population, the frequency of the two forms was caluculated based on the result by the cluster analysis(Euclidian distance, D_{jk}) of the morphorogical data, the length, thickness, angle and inflection point of curve of forceps.

The frequency of *lewisi* inversely proportioned to the geographical distance from the *lewisi*-monomorphic areas in Honshu, roughly. The frequency of *harmandi* was the highest in Aizuwakamatsu, the southern city of the Tohoku, and proportioned inversely to the distance from the site. In the Shikoku Island, the south of the Chugoku district, Forma *lewisi* and *harmandi* were higher in the western and eastern areas respectively. Thus, *lewisi*-monomorphic populations were found in the environmentally different areas of the southern region and the northern tip of Honshu. Polymorphic populations distributed between those and even in the south of the southernmost *lewisi*-area. This suggested that the two forms were genetically determined fundamentally and there were the gene-exchange and the geographical isolation even in Honshu. Further genetical and ecological observation is required in verification of the above speculation.

#17

DNA EVOLUTION AND ITS PHYLOGENETIC APPLICATION IN LEAFHOPPERS (HOMOPTERA: CICADELLIDAE).

Qingquan Fang, William C. Black, H. Derrick Blocker (Department of Entomology, Waters Hall, Kansas State University, Manhattan, KS 66506, USA.)

The different regions of nucleotide from nuclear ribosomal 18s rRNA gene, the ITS-2 region of the nuclear ribosomal RNA cistron, the 16s rRNA gene in the mitochondria genome and introns and coding regions from the histone H2A nuclear genes and the ribosomal protein S14 from leafhoppers (Homoptera: Cicadellidae) have been sequenced either directly from the products of PCR (Polymerase Chain Reaction) amplification or molecular cloning. The rates of evolution and the phylogenetic application of these genes are discussed in this paper. A phylogeny based upon molecular data from the sampled leafhoppers proposed and compared with that from morphological data. Some sequences were obtained directly from museum dried specimens.

#18

SYSTEMATICS AND BIOGEOGRAPHY OF THE GENUS *Lystridea* (HOMOPTERA : CICADELLIDAE). Kwang-Ryul Choe (Department of Agrobiology, College of Agriculture, Chungnam National University, Taejon 305-764, Korea)

The leafhopper genus *Lystridea*, heretofore known from but three species, is shown to comprise three distinct lineages, treated as species group. *Lystridea* are univoltine and populations mature early in the growing season. Females are brachypterous and incapable of flight, and the distribution of extant populations is characteristically disjunct. Seven species or subspecies, of which 4 are described as new, are characterized primarily on the basis of male genital structures. Geological events and other factors thought to be responsible for the disjunct distributional patterns of *Lystridea* are discussed.

#19

PHYLOGENETIC CLASSIFICATION OF THE TRIBE ERRHOMENINI (HOMOPTERA: CICADELLIDAE).

Y.J. Kwon, E.Y. Huh (Department of Agricultural Biology, College of Agriculture, Kyungpook National University, Taegu 702-701, Republic of Korea)

The tribe Errhomenini is redefined and the phylogenetic relationships of its subtribes with component genera are reviewed by means of cladistic analysis on the basis of morphological characters. Composition of the data shows the subtribe Malmaemichungiina to be more closely related to the Errhomenina than to the Bathysmatophorina. Thus, the former is a paraphyletic group. Subtribal and generic classification based upon the cladogram is presented and discussed.

#20

ELECTRON-MORPHOMETRIC TAXONOMY OF *MACROSTELES STRIIFRONS* ANUFRIEV FROM EAST ASIA.

Y.J. Kwon (Department of Agricultural Biology, College of Agriculture, Kyungpook National University, Taegu 702-701, Republic of Korea)

In an attempt to find reliable quantitative characters in discriminating the intraspecific relationships between geographically different populations of *Macrosteles striifrons* from East Asia, a morphometric multivariate analysis was undertaken. A sample of 20 individuals for each local population was taken at random from the appropriate collections, and totally 25 electronically measured characters were used. The result conformed the morphometric distinctions at the intraspecific level in certain local populations, although some groups overlapped slightly between them.

#21

CHINESE LEDRIDAE (HOMOPTERA: CICADELLOIDEA). Ping Cai (Department of Horticulture, Anhui Agricultural College, Hefei 230036, China), Chunglin Kuoh (Department of Plant Protection, Anhui Agricultural College, Hefei 230036, China)

This paper is the first report on the studies of Ledridae in the vast areas of China. The family of Ledridae is a little known family of leafhoppers. As yet, there is no one who has made such a systematic study of Ledridae in China. By the end of 1955, there were recorded only 31 species under 12 genera in China. For this reason, the authors et al. have been collecting and studying these insects since the late 1950's. As the result of over 30 years of research, the authors et al. have made a large collections of Chinese Ledridae, which have totalled up to 14 genera and 73 species. Among them 4 genera and 54 species are new to science, 2 genera and 12 species are reported as new records from China. In the paper, we only excerpted the list of species with distribution and host, the key to genera, the key to species of each genus and the characteristics of Chinese Ledridae on the distribution, host and appearance. The denomination of all new genera and species should be abided by the stipulation of the International Code of Zoological Nomenclature. And they also will be printed and published in the Acta Zoologica Sinica, Acta Entomologica Sinica, Acta Zootaxonomica Sinica.

#22

THE RECORD ABOUT INSECT OF DELPHACIDAE IN JILIN PROVINCE. Fuman Zhang, Fengxiang Wang (The Agriculture Research Institute of TongHua City, Jilin Province 135007, China) Jinhua Ding, Cunlin Hu (the Plant Protect Department of Nanjing Agriculture University)

Jilin province is located in northeast of China. It belongs to Ancient north edge on geographical divisions of the animal world. The investion of the species of Delphacidae was begun on 1979. From this year, we have investigated twentynine representive cities and countries in Jilin Province. The scope of work on the habitat type involved farming district, uncultivated land, unploughed solonchak land hilly country, planted forest, primary forest and district along the banks of rivers. More than a thousand sample were collected. Thirty-nine species have been identified, which belong to twenty-seven genera. Among them, Stenocranus spectabilis sp. n.(Waited to expertige) Garaga hailongensis Ding et Zhang (Journa of Nanjing Agricultural University 90.2). are the two new species which were discovered during the investigation. The eighteen species, Euconomelus lepidus (Boheman), Paraliburia adela (Flor. 1861), Megamelus notula (Germar, 1830), Colligypona revi (Fabricius), Javesella dubia (Kirschbaum), J. opscurella (Boheman), (Journal of Nanjing Agricltural University 88.4, 89.2, 90.2), and so on, are the new recorded species in China. The thirteen species, Euides spciosa (Bohe-an) are the first recorded in Jilin province.

#23

THE WAX-PORE PLATES ON ABDOMINAL TERGITES OF FULGOROMORPHA NYMPHS. Chung Tu Yang (Department of Entomology, National Chung Hsing University, Taichung, Taiwan, 40227, China)

The fulgoromorpha nymphs have been mostly neglected in literature. The specimens of about 180 species, of 18 families (including an unknown one) of fulgoromorpha nymphs were examined for secretory organs. The different wax-pore plate forms of each family are illustrated fully and arranged in a transformation series. Among them, nymphs of Tettigometridae, Delphacidae, and Meenoplidae presenting no pore on cuticular surface, are not included here. The nymphal specimens of Kinnaridae, Gengidae and Achilixiidae are not available to the author.

The developmental stages of each family are listed as follows:

Cixiidae	7 stages	Hypochthonellidae	1 stage
Achilidae	3 stages	Flatidae	5 stages
Derbidae	5 stages	Unknown	2 stages
Dictyopharidae	5 stages	Tropiduchidae	5 stages
Fulgoridae	3 stages	Nogodinidae	2 stages
Ricaniidae	2 stages	Issidae	6 stages
Eurybrachidae	2 stages	Acanaloniidae	3 stages
Lophopidae	1 stage		

#24

NEW SPECIES AND RECORDS OF DELPHACIDAE FROM NORTHWEST CHINA (HOMOPTERA: FULGOROIDEA). Guan-fang Hu, Jin-chuan Wang (Institute of Plant Protection, Gansu Academy of Agricultural Sciences, Lanzhou 730070, China), Jin-hua Ding, Chun-lin Hu (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China)

This paper deals with 3 new species and 15 new records belonging to 11 genera of Delphacidae collected from the Northwest China. Each newly recorded genus is redefined not only by the external morphological characters but also by the male genitalia. All new species and records are described and illustrated in detail. The types of new species are deposited in Department of Plant Protection, Nanjing Agricultural University. Ribautodelphax siculiformis, Gravesteiniella qitaiensis and Metropis nigroolypeus are new to science. Gravesteiniella boldi Tschikoica (Kusnezov), Metropis achnatheri Emeljanov, M. nigrifrons Kusnezov, Chloriona unicolor (Herrich-Schaffer), C. smaragduta (Stal), Herbalima limbata Emeljanov, Delphacodes eforiae (Dlabola), D. fenestratus Emeljanov, Megadelphax kangauzi Anufriev, Falcotoya minuscula (Horvath), Ribautodelphax notabilis logvinenko, R. tuvinus Anufriev, Javesella salina (Haupt), Kusnezoviella dimidiatifrons Kusnezov and Delphacinoides altaicus Vilbaste are newly recorded species.

#25

A CLADISTIC ANALYSIS OF GENERA OF APHIDIIDAE WITH DESCRIPTIONS OF FIVE NEW SPECIES. Nan Lu, Zheng-duan Ji(Department of Plant Protection, Hebei Agricultural University, Baoding 071001,China)

A cladistic analysis of Aphidiidae (20 genera) is completed by using PAUP program. Seventeen morphological characters and two biological characters are used in the analysis. One parsimonious tree (cladogram) is obtained. Based on the tree, a scheme of phylogeny is given. The twenty genera are divided into seven groups. The differences between the author's result and Mackauer's system and Stary's opinion are compared and discussed.

The present paper also reports the species of Aphidiidae in Hebei and Shandong provinces. Five species, Aphidius phragmitei n.sp., Binodoxys thevetiae n.sp., Lysiphlebia chengdensis n.sp., Pauesia taianensis n.sp., Trioxys ulmi n.sp., are new to science. Two genera, Diaeretus Foerster 1862 and Protaphidius Ashmead 1900, are the first reported in China. Three species are recorded for the first time in China as follows: Diaeretus leucopterus, Protaphidius nawaii, Praon dorsale. Four species are new to Hebei, and seventeen to Shandong. Fourteen genera and thirty-five species are keyed.

#26

GENETICS OF A WORLDWIDE COLLECTION OF RUSSIAN WHEAT APHID Gary J. Puterka (USDA-ARS, Appalachian Fruit Research Station, Kearneysville, West Virginia, 25430, U.S.A.), William C. Black IV (Department of Environmental Health, Colorado State University, Fort Collins, 80525, U.S.A., and Thomas O. Powers (Department of Plant Pathology, University of Nebraska, Lincoln, 68583, U.S.A.).

Genetic variation in a worldwide collection of Russian wheat aphid, Diuraphis noxia (Mordvilko), was investigated using electrophoresis of enzymes, DNA sequencing of specific regions of the mitochondrial genome, and polymerase chain reaction to amplify random regions of the aphid genome (RAPD-PCR). The aphid collections included eight isolates previously found to exhibit biotypic variation. Seventeen enzyme systems had sufficient activity for evaluating isozyme variation. Beta esterase, phosphoglucose isomerase, and 6-phosphogluconate dehydrogenase were found to be polymorphic between aphid populations. Sequencing five regions of the mitochondrial genome found no variation within the aphid population. Based on isozyme and RAPD-PCR analyses, the United States' population was most similar to the French and Turkish populations although they have been shown to differ biotypically.

#27

DISCOVERY OF LONGISTIGMA LIQUIDAMBARUS IN JAPAN. Kazuo Kawada (Lab. of Biol. Communication, Res. Institute for Bioresource, Univ. Okayama, Kurashiki 710, JAPAN)

Longistigma liquidambarus It was found as a new specise feeding Liquidamber formosana at Taihoku and Nanto in 1924 by Takahashi. Its appearance is very much limited and nothing about it has been reported since then.

In autumn, 1990 the emergence of this specise was noted in Kurashiki, Japan and it was the first record in Japan. After that their appearance was identified in Tsukuba, Kyoto, Osaka,Itami, Okayama, Kure, and Kochi cities ; thus we tend to believe that there is a possibility of its widespread and settled distribution.

Here I state their yearly seasonal prevalence and their overwintering etc.

#28

INFLUENCE OF TEMPERATURE ON THE POLYMORPHISM OF THE OVERWINTERING GENERATION OF THE CHINESE HORNED GALL APHID, SCHLECHTENDALIA CHINENSIS (BELL). Chuan-Xi Zhang, Hou-Lian Xu and Jue Tang (Zhejiang Agricultural University, Hangzhou, 310029, China)

The chinese horned gall aphid, Schlechtendalia chinensis, is a major species of chinese gall nut aphids. This paper deals with effect of temperature on the polymorphism of overwintering generation of this aphid. the resultant ratios of alatae to apterae observed under constant temperature of 4.5, 7.5, 10.5, 14.5, 18.0 and 22.0 °C were 100:0, 98.3:1.7, 68.3:31.7, 18.8:81.2, 2.0:98.0 and 0:100 respectively. whether the nymphs of overwintering generation developed into alate or aptera was determined during 2nd to 3rd instars.The number of sensoria on each antenna of alatae, which varied from 23 to 159, increased with decreasing temperature. Apeterous forms had only 2 primary sensoria on each of their antennae. The progenies produced by all apeterae, and the progenies produced by alatae at 18.0 °C, were parthenogenetic apterae with developed proboscis and stylets,and remained on mosses. But the offsprings produced by alatae which developed at 4.5-14.5 °C, were all sexuales. The results were discussed in relation to polymorphism as well as the artificial multiplication of this aphid.

#29

A STUDY ON CHINESE BAMBUSASPIS WITH DESCRIPTION OF SIX NEW SPECIES (HOMOPTERA: COCCOIDEA, ASTEROLECANIIDAE) . Xue-fan Zhang (Forestry Bureau of Huangshan City, Huangshan, Anhui 245000, China)

In this paper the scale insects of Bambusaspis which feed on the bamboos in China are studied. Among them, 12 species were recorded already. By new combination, there are 36 species that belong to this genus(including one variety). In addition, 6 new species are described. Up to now, there are 42 species of the genus Bambusaspis in China. All specimens are kept in the Forestry Bureau of Huangshan City, Anhui Province.

#30

THE STUDY ON THE SOFT SCALES OF CHINA. Gui-biao Han, Jin-juan Hao, Yuan Tang, Fang-teh Tang (Agricultural University of Shanxi, Taigu, 030801)

The soft scales are the most important group among scale-insects in China. Some of them is insect pests that can influence the growth of plants and even had plants dead, for example, the Citrus were seriously damaged by Ceroplastes rubens Mask. And lost 97.1 million yuan in Zhejiang province in 1934, others, such as Ericerus pela (Chav.), are the profitable insects to man that can secrete quantity of wax as the materials of industry. Otherwise the data of species recorded in China was scattered. Recent years, we paid attention to investigate and collect materials for study.

A relatively completed catalogue is reported. There are 40 genera and 98 species recorded in China, of which 16 species as new record to China and 5 species as new to science.

A completed key is given for identifying genera and species found in China.

#31

THE FINE STRUCTURE OF THE EGGS OF HETEROPTERA FROM CHINA. Shu-zhi Ren (Department of Biology, Nankai University, Tianjin 300071, China)

The studies on the eggs of terrestrial and aquatic bugs observed and compared by scanning electron microscope revealed detailes of chorion and eggs-bursters that are usefule in determining families, genera and species.

This research includes over 240 species from 34 families of Chinese Heteroptera. Through the work, many new characters in the Heteroptera eggs were discovered, which have both the complex varieties and stable regularities.

Keys are given to all families of Heteroptera, some genera and some species of Plataspidae, Pentatomidae, Coreidae, Rhopalidae, Lygaeidae, Nabidae and Nepidae, so the research of Heteroptera eggs has provided a meaningful determination of species groups as well as references for the study of the evolutionary relationships among families, genera and species.

The research provides a new basis for the taxa of Heteroptera through the external various morphology and colour of the eggs, the fine structure of chorion, egg-bursters and its biological study.

#32

BIOLOGY OF EGGS IN SOME TRUE BUGS (HEMIPTERA-HETEROPTERA) PART I, PENTATOMOIDA. M. Javahery, J.E.McFarlane (Department of Entomology & Lyman Entomological Museum, Macdonald College of McGill University, Ste. Anne de Bellevue, P.Q. H9X 1C0, Canada.

Biology of eggs based on 36 species of both Nearctic and Palearctic Pentatomoidea is described. The egg formation in relation to reproductive system for each species, outstanding characteristics of egg, incubation times, egg diapause, development of embryo, embryonic orientation, and egg eclosion in these bugs are discussed. The members of this superfamily are classified into 2 groups in relation to the form, position of egg-burster, and egg eclosion. Mechanisms of egg eclosion and emergence of first instar nymph in the five families of these bugs are included. An incomplete egg material collection of common true land bugs from the studied regions is now available. These eggs belong to 10 superfamilies of Pentatomomorpha and 5 of Cimicomorpha. All egg specimens are taken from culturing of known bugs collected in the 'Old' and 'New' world; this is the first eggs collection of true land bugs (Geocorisae) in North Ameica.

#33

OVARIOLE NUMBER IN *ELASMUCHA* BUGS (HETEROPTERA, ACANTHOSOMATIDAE) AND ITS IMPLICATIONS FOR A SALTATORY EVOLUTIONARY PROCESS. Shin-ichi Kudo (Entomological Institute, Faculty of Agriculture, Hokkaido University, Sapporo, 060 Japan).

In the Pentatomomorpha, the number of ovarioles in an ovary is generally 7 whereas in some species it is 3-6. The clutch size, however, is comparatively very variable among species, and there is no correlation between the ovariole number and clutch size. Exceptionally *Elasmucha* bugs have more than 17 ovarioles, and the number of ovarioles is variable not only among species but also within species. Moreover, females which have more ovarioles produced larger clutches within the limitation of the ovariole number. It is most likely that in *Elasmucha* the number of ovarioles have been selected via clutch size variation.

A possible scenario for the evolution of the *Elasmucha* ovary, including the process in which a saltatory novel variant was fixed in an ancestral *Elasmucha* population, is presented.

#34

ON THE JAPANESE FAUNA OF *LYGOCORIS* (HETEROPTERA: MIRIDAE: *LYGUS*-COMPLEX). **Tomohide YASUNAGA** (Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, 812 Japan)

The genus *Lygocoris* Reuter, 1896, of the subfamily Mirinae is a large group, containing 80 species under 4 subgenera throughout the Holaretic Region: *Lygocoris* s. str. (with 4 species), *Lygocorides* (1), *Neolygus* (51) and *Apolygus* (24). Hitherto, 19 species are known to occur in Japan. In the course of my study on Japanese fauna, at least 44 species are recognized. Among them, 2 species, *L. pabulinus* and *L. lucorum* are Holarctic, 2 species, *L. pulchellus* and *L. nigritulus* are Sino-Japanese in distribution, and the following 14 species are distributed over the Soviet Far East and Japan: *L. pabulinoides, L. idoneus, L. rubronasutus, L. lobatus, L. juglandis, L. hoberlandti, L. nemoralis, L. longiusculus, L. tiliicola, L. nigrovirens, L. hilaris, L. fraxinicola, L. furvus* and *L. subpulchellus*. There is only one Euro-Siberian species, *L. spinolae*. The remainder, 25 species, are known only in Japan and her adjacent territories, and are all undescribed. They include an interesting species from the Bonin (Ogasawara) Islands, which is regarded to represent a new subgenus. The male genitalia of this species exhibit such a special feature as the vesica showing the intermediate condition between the subgenera *Neolygus* and *Apolygus*.

#35

ABUNDANCE AND SPECIES COMPOSITION OF LYGUS BUGS (HETEROPTERA: MIRIDAE) ON DIFFERENT CROPS IN FINLAND. Varis, Anna-Liisa (Department of Applied Zoology, University of Helsinki, SF-00710 Helsinki, Finland)

Lygus populations on eight field crops in southern Finland were surveyed in 16 successive years by means of sweep net samples taken once a week throughout the growing season. The dominating species on all crops was L. rugulipennis, constituting 92 % of the total number of adults. L. gemellatus, L. pratensis, and L. punctatus occurred in small numbers, and L. wagneri was found occasionally. The abundance of bugs was highest on wheat. The effect of weather on the abundance of lygus bugs is discussed.

#36

GEOGRAPHIC VARIATION OF TWO SUBSPECIES OF THE PALAEARCTIC WATERSTRIDER *GERRIS COSTAE* (HETEROPTERA: GERRIDAE) IN THE ALPS AND THE APENNINES.

C. R. Largiadèr[1], C. P. Klingenberg[2] and M. Zimmermann[1] ([1]Department of Population Biology, Institute of Zoology, University of Berne, Baltzerstrasse 3, CH-3012 Berne, Switzerland; [2]Department of Entomology, University of Alberta, Edmonton, Alta. T6G 2E3, Canada)

The previously described subspecies of the waterstrider *Gerris costae* can be reliably distinguished by morphometric characters (KLINGENBERG 1992). *G.c.costae* is confined to higher altitudes in the Alps whereas *G.c.fieberi* is also found in the lowlands in south-eastern Europe and Italy. Their distributions suggested a zone of contact in the Maritime Alps. We studied the geographic variation of the two subspecies in the Alps and the Apennines by means of multivariate morphometric methods. We analysed females and males separately and obtained concordant results for both sexes.

We used canonical variate analysis to allocate individuals of different regions to one of the two subspecies. Individuals with scores intermediate between the two subspecies were found from the Maritime to the Western Alps. Within this area we found two geographic trends in morphometric variation: from North to South, and from high to low elevation morphometric variation of our samples approached the variation of pure *G.c.fieberi*-samples.

Canonical trend surface analysis revealed similar geographic trends of morphometric variation. High correlation coefficients between the canonical variate scores of the two separate analyses suggest that they show identical geographic trends.

Comparisons of the pattern of morphometric variation of laboratory-reared offspring with the pattern of their parents sampled from natural populations show that geographic variation is mostly determined genetically. Intermediate individuals from field populations could be identified as natural hybrids between the two subspecies since laboratory-reared hybrids scored intermediate between the offspring of pure strains.

#37

ADVANCES IN THE SYSTEMATIC AND BIOLOGICAL STUDIES OF THYSANOPERA FROM CHINA. Yun-fa Han(Institute of Zoology, Academia Sinica,Beijing)

A critical historical review of previous systematic and biological studies and other works on Chinese thrips is presented. The thrip fauna of China has received more attention in the last 20 years than during the remainder of its taxonomic history. There are now in all 286 known Chinese thrip species distributed among 104 genera. A synopsis is given of all genera with their present status and number of species. From unpublished results it is expected that the number of species will exceed 400 and that some more genera will be described in the near future. A list of 27 important pest species is given, and information on their host plants and distribution data, life history, adult female reproductive capacity and longevity, natural enemies and controls is provided. The Thysanoptera collections and the taxonomic entomologists presently engaged in the study of the group in China are introduced. Several areas of future research are suggested. The " Literature Cited" lists 250 references.

#38

A REPORT ON THE SPECIES OF THE ORDER THYSANOPTERA FROM CHINA. Wei-qiu Zhang,Xiao-li Tong(Lab. of Insect Ecology,South China Agricultural University,Guangzhou,510642,China)

A short history of studying on thrips fauna in China was reported. Before 1970,there was few Chinese working on thrips taxonomy. Only 27 thrips species were recorded in "Catalogus Insectorum Sinensium I-IV" by Wu.C.F.(1935-1941). In fact,a real study of thrips taxonomically was commenced in the early 1970's. From that time on,a great progress has been made in the field of thrips taxonomy in China. According to date collected,about 100 genera and 270 species have been recorded in China,including more than 30 new species which were discovered by Chinese scientists. It was theoretically estimated that there were at least 500-600 species occurred in China and there would be more thrips species to be discovered in China. It is necessary to study the thrips fauna of China continuously.

A list of thrips with their hosts and distributions from China was provided in this paper.

#39

A NEW GENUS OF THRIPIDAE(THYSANOPTERA),WITH TWO NEW SPECIES FROM CHINA. Xiao-li Tong, Wei-qiu Zhang (Lab. of Insect Ecology, South China Agricultural University,Guangzhou, 510642, China)

A new genus *Graminothrips*(Thripidae, Thysanoptera) was erected with two new species *G. cyperi* and *G. longisetosus*. The new genus was closely related to the grass-living genera *Agriothrips* Ananthakrishnan from South India and *Yoshinothrips* Kudo from Japan.but easily distinguished from them by the following characters:(1) maxillary palpi 2-segmented; (2)male without ocelli; (3) interocellar setae well-developed, placed outside ocellar triangle; (4) abdominal tergites I-VII with teeth along posterior margin on sides. sternites II-VII with irregular teeth along posterior margin; (5) tergites III-VII with 5 pairs of setae respectively. Type species *G. cyperi* body bicoloured, yellow and brown;postocular and pronotum posteromarginal setae minute; intetrocellar setae anterior to fore ocellus; sternites III-VII each with 9-14 irregular scattered glandular areas. Whereas *G. longisetosus* body largely brown; postocular setae and pronotum posteromarginal setae very long;interocellar setae behind fore ocellus; median pair of metascutum close to anterior margin; sternite II with irregular 4 glandular areas,III-VII each with two rows of 8 scattered glandular areas. All types are preserved in the Insect Collection of South China Agricultural University.

#40

INVETIGATION ON AGRICULTURAL THRIPS AND DESCRIPTION OF THE IMPORTANT SPECIES IN NINGXIA. Cai-xia Yang, Xian-fang Cha (Institute of Plant Protection, Ningxia Academy of Agro-forestry Scinces, Yinchuan 750002, China)

Thrip is, an important population of agro-economic insect pests. In despite of much research on a great number of species of insects in the last 40 years in Ningxia, little effort has ever been made on such small-figured insect as thrips. Therefore, an investigation, collection, classification and identification of agricultural thrips in Ningxia were implemented from 1986 & 1988 of 22 species of 12 genera in 3 families that preliminarily studied, 21 and 1 species were harmful and beneficial, respectinely. The population composition. harmfulness and life habit of the main species were systematically investigated and 10 species harmful cereal crops were biologically described.

#41

A PRILIMIMARY STUDY ON ALFALFA THRIPS-RESISTANT BREEDING. Wu Yongfu, Temuer Buhe (Department of Grassland Scince, Inner Mongolia Institute of Agriculture and Animal Husbandry, Huhhot, Inner Mongolia 010018, China)

Thripses are the most widespread harmful insects for alfalfa production in China. In the current study which was initiated in 1984, an effort was made to improve the thrips-resistance of alfalfas by means of breeding and selection. More than 400 accesses of Medicago sativa and Medicago media materials have been scanned so far, however, none of them showed an accountable thrips resistance. One Medicago ruthenicus material was found to be highly thrips resistant and its resistant performance reaches an immune level. Most of the hybrid descendants from the cross between M. ruthenicus and M sativa (or M media) showed high thrips-resistances (also esistant to aphides). Very few individual plants were selected from M. sativa and M media, which showed a promising high thrips resistance. By vegetative propagation of these plants and followed by recurrent selection, thripes resistance of the alfalfa was improved. A further study involves interspecies hybredization of M. sativa and wild M. ruthenicus and recurrent selection is under way and looks fromising in improving alfalfa's thrips resistance. Main morphological characteristics of the plants for thrips resistance (also aphide resistance) include: leaves densely pubescent, culticle thick and coarse.

#42

ON LIAOXIMORDELLIDAE FAM. NOV. (COLEOPTERA, INSECTA) FROM JURASSIC OF WEST LIAONING PROVINCE, CHINA. Wen-li Wang(Institute of Natural History, Beijing Natural History Museum)

In the autumn of 1988 and 1989, some fossil insects were collected from Late Jurassic Yixian Formation (J_3Y) of Daxinfangzi village, Lingyuan County, West Liaoning Province of China, and a new familly Liaoximordellidae is erected and described in this paper. The speciemen was obtained from the greyish-while tufflava; along with some fish(Lycoptera), plant and molluscan fossils which were also collected from this horizon.

New familly is alike to Praemordellidae Barovskaja, 1929, but it may be distinguished from the latter by the insect body did not arch and the head was prognathous; hind-legs slender, tibiae long and abdomen with 6 segments.

#43

FUNGI ASSOCIATED WITH PINE-INFESTING BARK BEETLES IN SOUTHERN AFRICA AND THEIR POSSIBLE ORIGINS

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Three species of pine-infesting scolytid bark beetles, believed to be of European origin, occur in Southern Africa. These include *Orthotomicus erosus*, *Hylurgus ligniperda* and *Hylastes angustatus*. Surveys of fungi from these insects have primarily yielded *Ophiostoma* spp. or their anamorphs including *Leptographium* spp., *Graphium* spp. and *Sporothrix* spp. Up to twelve species of the fungi have been found associated with a single insect species. These include well known taxa such as *Ophiostoma ips* and *Leptographium serpens* as well as numerous fungi yet to be described. Many of the fungi have been found on similar insects in Europe. However, surveys of fungi associated with these insects in their native habitats have not been thorough making comparisons difficult. The taxonomy of these fungi is also poorly defined which has led to considerable confusion. Molecular techniques are currently being used to characterize the fungi. Results for instance suggest that *L. lundbergii*, commonly associated with pine root-infesting scolytids in Europe, is conspecific with *L. truncatum* associated with similar insects in Southern Africa. This would solve one of the more curious anomalies relating to the Southern African situation. It is hoped that additional surveys of fungi associated with pine-infesting scolytids in Europe, as well as taxonomic studies, will lead to more meaningful comparisons between the mycoflora of insects in their areas of origin and in introduced situations.

#44

THE SPHODRINA (COLEOPTERA:CARABIDAE) OF CHINA. Achille Casale (Istituto di Zoologia dell' Università, Via Muroni 25, 07100 Sassari, Italy).

Sphodrina are a holarctic-macaronesian line of Carabid beetles including almost 300 species belonging to 13 different genera (Casale, 1988).The largest part of the species of the phyletic line of Laemostenus are distributed in the Euro-Mediterranean, West-Asian and Himalayan regions; on the contrary, almost all species and the 9 genera of the Sphodrus phyletic line are typical of Central and East Asia, often endemic in small areas. These taxa present interesting adaptive characters to different ecological conditions,to open, eremic environments, to Sibirian taiga, to temperate forests and to high mountain biotopes. No troglobitic Sphodrina are known from China.Till now,31 species of Sphodrina were reported from China, of the genera Taphoxenus, Pseudotaphoxenus,Reflexisphodrus and Eosphodrus. Recent founds of a new species of Reflexisphodrus in Shanxi prov.,and of a new species of Pseudotaphoxenus in Sechuan, considerably extend the distribution of these genera in the country, and give new informations on the biogeography of the group in East Asia. Particularly, the second genus shows a wider occurrence also in the southern, humid forests of the area.

#45

NOTES ON THREE CARABUS SPECIES (COLEOPTERA:CARABIDAE) OF SIBERIA. Achille Casale (Istituto di Zoologia dell'Università, Via Muroni 25,07100 Sassari,Italy), Oleg Berlov (Kafedra Zoologii, Irkutsk Agricultural .Institut, 664038 Irkutsk, Russia), Pier Franco Cavazzuti (Museo di Storia Naturale,10100 Carmagnola, Italy).

Two centuries of taxonomic researches on the genus Carabus (in the widest sense) widely demonstrated the narrow limits of many morphological features in phylogenetical reconstructions: convergences, adaptive characters to the same trophic specialization or to similar environments, parallel evolution of the elytral sculpture, invalided several previous attempts of classification of the genus.

A good example can be found in the case of three species here examined, i.e.: Carabus gebleri Fischer,1817, Carabus dshungaricus Csiki, 1927, and Carabus tarbagataicus Kraatz,1878.Placed in the past in different subgenera because of divergent external features, they show close affinities in the synapomorphic characters of endophallous and of larval morphology. Furthermore, their actual distribution could be the result of an allopatric speciation by vicariance in mesic refuges of Southern Siberia and Tarbagatai Mountains.

#46

STAPHYLINIDAE (COLEOPTERA) FAUNA OF THE CRIMEA AND ITS ORIGIN. Gusarov,V.I.(Dep.of Entomology, Leningrad State University, Leningrad 199034, USSR)

Reconstruction of the historical development of the Crimea fauna based on geographical distribution of the species from different habitats has been done.In Pleistocene glaciations most of thermophilous Pliocene species including endemics became extinct in the Crimea (modern endemism level-2%). Few of them survived in the Southern Crimean Coast refuges.The latter were not available for forest species from Russian plain,the steppe barrier constantly existing.In glaciations boreal species penetrated the Crimea but most of them disappeared in Holocene (they survived in the Caucasus).Hygrophilous species came to the Crimea at the beginning of each interglaciation,when it was already warm,Black Sea was fresh and its level was lower.

#47

THE PARASITOID RECORDS IN GUIZHOU PROVINCE, CHINA. Sheng-zhen Zhou(Plant Protection Station General, the Agricultural Department of Guangdong Province, Guangzhou 510500, China)

144 parasitoids of agriculture and forest pests were recorded from Guizhou province, China, including Ichneumonidae 61 species, Braconidae 27 species, Aphidiidae 4, Trichogrammatidae 5, Mymaridae 3, Elasmidae 2, Chalcididae 4, Torymidae 1, Aphelinidae 2, Eulophidae 8, Pteromalidae 3, Encyrtidae 6, Eurytomidae 1, Eupelmidae 2, Scelionidae 4, Ceraphronidae 2, Platygastridae 2, Bethylidae 2, Dryinidae 5. Some of them are new records in Guizhou. Each species has diagnosis with other informations.

#48

KARYOTYPES OF THE TWO JAPANESE FIREFLIES.

HOSHIBA, Hidchiro [1], SAKAI, Seiroku [1] and ABE, Norio [2] ([1] Institute of Biology and Life Sciences, Daito Bunka University, Takasaka, Saitama, Japan 355 and [2] Itabashi Green House Botanical Garden, Itabashi, Tokyo, Japan 175)

We observed the chromosomes of the two Japanese representative species of the fireflies, *Luciola lateralis* and *L. cruciata* and results were compared to those of previous cytological data and discuss with other recent data on the behavioral, chemo-taxonomical studies. Both species have been bred at Itabashi Green House (*L. lateralis* are originally collected from Kuriyama, Tochigi pref. and *L. cruciata* are from Futaba, Fukushima pref.

The chromosome number of *L. lateralis* was 2n=18, the chromosomes consisted of 4 meta-centrics, 10 acro-centrics, 2 micro-chromosomes and X(acro), Y(micro), and that of L. cruciata was 2n=18 with 10 meta-centrics, 6 acro-centrics and X(meta), Y(micro). The previous data of these species from Ehime pref. (Inoue & Yamamoto, 1987) were 2n=18 with all acro-centrics in the former, and 2n=16 with all acro-centrics in the latter. This observation is reliable in the number, but there might be technological limitations to determine the chromosome morphology.

In L. lateralis, some variations depending on the collected districts were found in the radiation patterns of light and in the disc electrophoretic patterns of homogenates. Our chromosome data suggested the possibility of similar interspecies segregation also in *L. cruciata*.

#49

STUDIES OF THE CLASSIFICATION ON CANTHARIDAE (COLEOPTERA) IN CHINA. Sujian Wang (Dept. Biol. Sci. Biotech. Tsinghua University, Beijing 100084, China)

In this paper the classification of Chinese Cantharidae is studied. Forty-one species are described and illustrated, belonging to eleven genera and two subfamilies, among which one genus (Paradiscodon) is new record to China, another genus (Micropodabrus) is new record to mainland of china except Taiwan island; twenty-four new species are recorded, two new record species to China are described. All 309 species of Cantharidae in China are cleared.

#50

CLASSIFICATION OF THE PUPAE OF CHAFER (Coleoptera, Scarabaeoidea). De-xu Shun, Zhi-liang Zhang(Department of Plant Protection, Shenyang Agricultural University, Shenyang 110161, China).

The present study deals with the morphological observation of 10 Melolonthidae pupae, 5 Rutelidae pupae, 4 Cetoniidae pupae, 3 Dynastidae pupae and 2 Sericidae pupae. The main characters used as the basis for classification are, the shape of clypeus and antenna, the char acteristics of pronotum, the presence of absence of the prosternal and the mesosternal process, the cotour and the shape of spiracle, the number and position of stridulating organs, the shape of caudal portion, the bifurcation angte of 2 caudal horns and the shape of external genitalia of male pupa. The habit and domestic distribution of each chater are also described briefly.

#51

AN ANOMALA CUPRIPES GROUP FROM SOUTH CHINA WITH SOME TAXONOMIC DISCUSSIONS. Ping Lin (Guangdong Entomological Institute, Guangzhou 510260, China)

All three species, A. cupripes Hope, A. rubripes sp. nov. and A. platycorna sp. nov., composing a natural related group on their male and female genitalia and other main characteristics are described in this paper. The A. rubripes sp. nov., a serious pest in Southern China and Taiwan Island, has been misidentified as A. cupripes Hope since 1915 by ohaus. The real A. cupripes Hope was collected in the southwestern part of Yunnan as a new record from China. Descriptions, discussions, distributional ranges and differentiation including figures of male and female genitalia about this three species are given.

#52

COMPOSITION AND GEOGRAPHIC DISTRIBUTION OF THE FAUNA OF TENEBRIONID BEETLES (COLEOPTERA, TENEBRIONIDAE) OF MONGOLIA. Medvedev, G.S. (Zoological Institute, Russian Acad. Sci., St. Petersburg, 199034, Russia).

168 species of tenebrionids are found in natural habitats within the territory of Mongolia, 82 species (48.8%) are endemic for this territory. A complex of forest tenebrionids comprises 7 species of the genera Corticeus, Upis and Bius. Fauna of mountain forest-steppe, mountain steppe and steppe comprises 59 species (35.1%). Desert steppe has the richest fauna of tenebrionids in Mongolia (91 species — 54.1%). Desert steppe occupies an intermediate position between steppe and deserts, having sharply different faunas, but possesses a fairly peculiar fauna of their own (28 endemic species — 30.7%). 80 species (47.6%) are recorded in the deserts of Mongolia. Deserts of different types share only 5—16% of species in common. Analysis of the fauna of tenebrionids of Mongolia shows that in the course of differentiation of the fauna of arid regions of the Palaearctic into the northern and southern types the Mongolian fauna developed as a variant of the northern type.

#53

ON THE FAUNA OF CHRYSOMELOIDEA IN THE HENGDUAN MOUNTAINS REGION, CHINA. Shu-yong Wang, Juan-jie Tan(Institute of Zoology, Academia Sinica, Beijing 100080, China)

The Hengduan Mountains Region located at the southeeastern border of the Qinghai-Xizang Plateau, being famous for its physical geography and its fauna and flora. The investigation of insect fauna in this region, carried out by the Insect group of the Comprehensive Scientific Expedition to the Qinghai-Xizang Plateau, Academia Sinica in year 1981-84, shows that the study of the insect fauna of Hengduan Mountains Region bearing on very important significance to the investigations of the origin, formation and evolution of the fauna of Qinghai-Xizang Plateau. The fauna of Chrysomeloidea in the Hengduan Mountains Region is characterized by its complexity, rich of species and higher taxa, and also marked by its very density congregate alpine species. According to the taxonomic identification, up to the present the fauna of Chrysomeloidea there comprises 16 subfamilies, 150 genera and 536 species among them there are 6 new genera and 211 new species. We regard that the key to inquire into the origin and evolution of the insect fauna there is to study the course of formation of the alpine species. According to the analysis of the faunal constitution of many genera of Chrysomeloidea now existing, the Hengduan Mountains Region is not only the certer of distribution and differentiation of species , tut also very probably. the place of origin of the neighboring faunas.

#54

The use of Isoelectric Focusing to solve systematic problems in the genus *Phyllotreta* (Coleoptera, Chrysomelidae).

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The genus *Phyllotreta* (Coleoptera : Chrysomelidae) is a group of specialised herbivorous beetles, mainly feeding on cruciferous plants. Within this group several sibling species complexes can be recognised.

Recently a study on the systematics and population genetics of some of these species was started. To solve some of the systematic problems we used isoelectric focusing (IEF) to separate several closely related species belonging to the *Phyllotreta cruciferae*-complex.

IEF was done using gels with a pH-gradient 4-6,5. We used silver staining to stain for general proteins. The obtained patterns were interpreted quantitatively using the band-counting technique and dendrograms were constructed using UPGMA. A comparison was made between several populations.

#55
SYNOPSIS OF THE WEEVIL FAUNA OF KOREA (COLEOPTRA: CURCULIONOIDEA). Jeong-Deog Bae (Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, 812 Japan)

Weevil fauna of Korea is discussed from the view points of the historical and ecological zoogeography.

In the Plio-Plistocene, Korea and Japan were in a continental stage and their weevil fauna might be almost common. Most of them might be perished later by the cold temperature, or some archaic forms were diminished by the migration of the advance ones. The remnants of this age were limited to the species living in the soil and speciated locally.

In the Plistocene, especially in the Maximum Würm Glacial, northern elements migrated to the Korean peninsula and/ or to Japan as the refugia from north.

In the Holocene, the northern elements changed their distribution to the north or to the high mountains in accordance with the regression of cold temperature. At the same time, the warm-temperate or subtropical elements have migrated across sea from south ridding on the marine current and strong winds.

#56
A TAXONOMIC STUDY OF THE CHINESE ELATERIDAE (COLEOPTERA). Shi-hong Jiang (Department of Plant Protection, Huazhong Agricultural University,Wuhan 430070, China)

The species of Elateridae is very rich in China, but little taxonomic study was done formerly. Liu (1932) and Wu(1937) only recorded 174 species of the Chinese Elateridae. Since 1985, I has collected a large amount of the taxonomic literature and a lot of the click-beetle specimens from many districts of China. Through identification and the taxonomic study to them, the number is increased by over 420 species, which are divided to 91 genera, 10 subfamilies: Oxynopterinae 19 spp., Hypnoidinae 16 spp., Pytiobiinae 5 spp., Pyrophorinae 86 spp., Denticollinae 82 spp., Elaterinae 123 spp., Oestodinae 8 spp., Cardiophorinae 35 spp., Melanotinae 44 spp., Negastriinae 8 spp.. More than 200 species are redescribed, and several new species and new record from the Chinese fauna are given. The keys to the subfamilies, tribes, genera and species of the Chinese Elateridae are provided. The geographic distribution of the Chinese Elateridae is also analysed preliminarily. Now I am going to identificate the other click-beetle specimens. I am sure that the study will make the species number of the Chinese Elateridae increase greatly.

#57
STUDIES ON THE SYSTEMATIC POSITION AND GENERIC RELATIONSHIPS OF THE TRIBE EPILACHNINI (COLEOPTERA: COCCINELLIDAE) FROM YUNNAN. Hong Wang(Laboratory of Pollination Biology, Kunming Institute of Botany,Academia Sinica, Kunming, Yunnan 650204,China),Cheng yi Cao (Department of Forest Protection, Southwest Forestry College, Kunming,Yunnan 650224,China)

This paper deals with the systematic position and generic relationships of the tribe Epilachnini based on the morphological characteristics, especially on the basal teeth of the tarsal claws, lateral teeth of mandibles, on male and female genitalia. Applying cladistic methodology,the authors also discussed phylogenetic relationships within the tribe. Five genera, i.e. Epilachna, Afidenta, Afissula, Henosepilachna, Afidentula, are selected as the taxa for cladistic analysis. A taxonomy based on the cladogram is different from the orthodoxa one. The genus Epilachna should be divided into three phylogenetic groups. A subgeneric rank for the three groups is accepted in this treatment. Two new subgenera of Epilachna, i.e. Aparodentata Cao et Wang, Uniparodentata Cao et Wang, are described.

#58
STUDIES ON TAXONOMY OF SCYMNINI(COLEOPTERA:COCCINELLIDAE) OF CHINA. Shun-xiang Ren, Xiong-fei Pang(Lab. of Insect Ecology, South China Agricultural University,Guangzhou,510642,China)

The tribe Scymnini belongs to the subfamily Scyminae of the family Coccinellidae. The distribution of Scymnini is worldwide,and the resource is abundant. Up to present, 25 genera, including 13 subgenera and more than 1000 species have been known in the world.

In the present paper,the historical reviews of Scyminae and Scymnini were looked back in summary;the systematic position of Scymnini was discussed briefly. The Scymnini from China was taxonomically studied,including 9 genera,6 subgenera and 134 species. Among them,48 species were new to science, 1 genus and 3 species were new records for China.

#59
A NEW SPECIES OF THE GENUS IOESSE THOMSON FROM CHINA (COLEOPTERA: CERAMBYCIDAE: LAMIINAE). Li Chen, Shu-nan Chiang (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

A new species, Ioesse medogensis sp. nov., from Xizang Autonomous Region (Medog county) of China was described in this paper.

The species differs from the only recorded species I. sanguinolenta Thomson in the body pitchy black instead of reddish brown;the antennae one and half again longer than body in male instead of about reaching the tip of abdomen; the antennal segments largely rellow beyond the 3rd and blackened basally and apically instead of uniformly black; except reddish brown on scape, only the 3rd and 4th joints sparsely fringed beneath instead of fringed on the 3rd to 6th or 7th joints.

#60
NOTES ON THE GENUS GNATHOSTRANGALIA HAYASHI WITH DESCRIPTIONS OF TWO NEW SPECIES FROM CHINA (COL.: CERAMBYCIDAE). Li Chen, Shu-nan Chiang, Wenkai Wang (Department of Plant Protection, Southwest Agricul. Univ., Chongqing 630716, China)

The genus Gnathostrangalia was established by Hayashi in 1985. In comparing with the allied genus Pygostrangalia, this new genus is characterized by the "longer forehead, broader prothorax with more developed hind angles, broader elytra at base and rather straightly narrowed posteriorly." Five species have been transfered into this new genus, they are: Strangalia aurivillei Pic (Tonkin), S. rufovittata Pic (Tonkin), S. longiceps Aurivillius (Borneo) and S. tienmushana Gressitt (China), Leptura bilineatithorax Pic (Tonkin). There was only a single known species from China. In this paper, two additional new chinese species are described:(1) Gnathostrangalia simianshana sp.nov. from Sichuan province, and (2) G. nigriventris sp. nov. from Guangxi province. A key to chinese species of the genus Gnathostrangalia is provided.

#61
ROLE OF EXTERNAL GENITALIA IN THE TAXONOMY OF SUB-FAMILY BRACHYDERINAE (CURCULIONIDAE:COLEOPTERA).
S.S.Gandhi & H.R.Pajni(Department of Zoology, Panjab University, Chandigarh, India.

A study of male and female genitalia in 99 sps. of Brachyderinae reveals that the shape of aedeagus, length of aedeagal and phallobasic apodemes, type of endophallic armature, presence or absence of styles and the length of ovipositor show variation at the level of different taxa. The subfamily is distinct in having styles on the apices of the coxites. At the tribal level, the tribes Blosyrini and Dermatodini are free from any parameral processes. The former also has rounded or subtruncate aedeagus and complex endophallic armature. The tribe Dermatodini possesses unusually long aedeagal apodemes, short and typically shaped aedeagus and a hook-shaped rod on the endophallus. Under the tribe Tanymecini, the subtribes Piazomiina and Tanymecina can be divided each into 2 categories on the basis of attachment of aedeagal apodemes and length of ovipositor. Several genera show a constant type of male genitalia characteristic of each. The subgenera under a few of them can also be differentiated from their special structure of ovipositor. The Fauna under the remaining four tribes has species-specific differences in the male genitalia.

#62
EVOLUTION AND DIMORPHISM OF AEDEAGUS IN ORIENTAL BATRISINAE (COLEOPTERA, PSELAPHIDAE).
SHUHEI NOMURA (Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, 812 JAPAN)

In many species of the subfamily Batrisinae, the male has **asymmetrical aedeagus.** The asymmetrical structure has presumably been evolved from the symmetrical and tubular aedeagus with an lamellar plate formed from the parameres and well-sclerotized endophallus. Each species of *Batrisocenus* and its allied genera has a "**dorsal apophysis**" which is articulated on dorsolateral (right or left) side of the median lobe of the aedeagus. The dorsal apophysis is not derived from the parameres, but probably from the dorsal wall of the median lobe.

These aedeagi can be classified into two types, i. e. one type named **right-articulated type (RA)** having the dorsal apophysis on the right side of the median lobe, and the other **(LA)** on the left. Many species have one type of the asymmetrical aedeagus; but some species each has a striking **dimorphism including both types of RA and LA** within the same population. In one of the dimorphic species, *Batrisceniola dissimilis* (SHARP), the dimorphism is occured in many local populations with **50 % to 80 % ratio of the LA**. But as an exception, no LA individual was found from one local population (Hakone, Central District of Japan). Such phenomenon is not only a great interest of genetic study, but also extremely suggestive for the phylogeny of the subfamily Batrisinae.

#63
CADDIS FLIES (TRICHOPTERA) FROM A MOUNTAIN RAIN FOREST IN NE TANZANIA.
Trond Andersen(Zoological Museum, University of Bergen, Musepl. 3, N-5007 Bergen, Norway)

Caddis flies were collected in Malaise-traps along the stream Kaputu in the rain forest reserve Mazumbai in the W Usambara mountains in NE Tanzania during October and November 1991. The stream originates at 1880 m a.s.l. and flows through the forest down to 1400 m a.s.l., where it ends up in a marshy area. There are two larger water falls, but also more lentic stretches; in the lower reaches the stream is 3 to 4 m wide. The water temperatures measured varied between 14.6°C and 17.6°C, the pH was 5.8.

Malaise traps were located at 12 different sites along the stream; each trap operated for a minimum of 10 days. A total of approx. 6000 specimens were caught, representing some 50 species in 14 families. Hydroptilidae with at least 11 species in 6 or more genera, Philopotamidae with 9 species in two genera, Hydropsychidae with 5 species in 3 genera and Leptoceridae with 8 species in 6 genera were the dominant families.

Most species were distributed along the whole length of the stream, while some, like *Agapetus* sp. (Glosssosomatidae) were only taken in the upper reaches and others, like *Dipseudopsis bidens* (Dipseudopsidae) only in the lower reaches.

#64
AN INDEX-CATALOGUE OF CHINESE TETTIGONIODEA (GRYLLOPTERA).
Xing-Bao Jin*, Kai-Ling Xia (Shanghai Institute of Entomology, Academia Sinica, Shanghai, 200025, China)

The known species of the Chinese Tettigoniodea include all the long-horned grasshoppers, katydids, camel crickets, cave crickets and leaf-rolling crickets, excepting the true crickets and mole crickets, the Gryllodea. They are listed and indexed with their original references and synonyms, types and their depositories, the known distribution in China and the presence of specimens in the museum of Shanghai Institute of Entomology, Academia Sinica. The catalogue involves 3 superfamilies and 12 families: Stenopelmatoidea including Stenopelmatidae and Gryllacrididae; Rhaphidophoidea including Rhaphidophoidae only; Tettigonioidea including Bradyporidae (Zichyinae), Phaneropteridae, Pseudophyllidae, Meconematidae, Phyllophoridae, Mecopodidae, Tettigoniidae (Tettigoniinae and Saginae), Conocephalidae (Conocephalinae and Listroscelidinae) and Tympanophoridae. In total, 340 species are catalogued. The geographical territory covered by the catalogue includes both mainland China and Taiwan, some parts of (outer) Mongolia, Ussuri region (border of USSR), Hymalaya (border of India) and Tonkin (border of Vitenam) regions.

#65
A SYSTEMATIC STUDY OF TENTHREDININAE FROM CHINA (HYMENOPTERA, SYMPHYTA, TENTHREDINIDAE).
Decheng Yuan (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Tenthredininae contains about 1180 species of 35 genera from all continents, of which 215 species of 18 genera had been recorded from China before the present work.

In my Ph.D. dissertation under the guidance of Prof.H.F.Chu 295 species and 9 subspecies in 20 genera of Tenthredininae are recorded, of which 84 species and 4 subspecies are new to the recorded fauna of China and 4 species are new to science. Following new synonymy are proposed: Conaspidia scutellaris Malaise,1945 = C. kalopanacis Xiao et Huang,1982; Aglaostigma karenkonis (Takeuchi,1929) = Laurentia sinica Takeuchi,1940; Tenthredo nimbata Konow,1906 = T. mainlingensis Xiao et Zhou, 1988; T. parcepilosa Malaise,1945 = T. medogensis Xiao et Huang,1988. The genus Colochela Malaise is newly synonymized with the genus Neocolochelyna Malaise, a redescription of the genus Neocolochelyna is given.

The development of the fauna of Tenthredininae in China is discussed by combining the results of generic cladistic and biogeographic analysis, with consideration of geological and fossil evidences. It is proposed that China is one of the most important distribution centers in the world, especially the mountain areas in S.W. China are highly rich with endemic components old or newly formed.

#66
HOST ASSOCIATIONS OF THE MICROPTERYGIDS (LEPIDOPTERA:ZEUGLOPTERA).
T. Yasuda, Entomological Laboratory, University of Osaka Prefecture, Sakai, Osaka, 591 Japan.

The larvae of the micropterygids feed on Bryophyta, primarily liverworts in their habitat.

Observations of Paramartyria species in Japan suggest that considerable isolation may exist among populations on different liverwort species. Paramartyria semifasciella has been reared only from Heteroscyphus beschereilei (Steph.) [Jungermanmiales Lophocoleaceae]. Similar moths reared from Cephalozia otaruensis Steph.[Jungermanmiales: Cephaloziaceae] at Mt. Hikosan in northern Kyushu are new species. The widespread P. immaculatella have no recorded host, but the adults were observed on ferns and bryophytes in their habitat.

The larvae of Neomicropteryx and Epimartyria exploit phylogenetically advance Bryophyta order Marchantiales.

Information in the literature indicates no overlap by two or more species in one host Data are too fragmentary as yet to permit firm conclusions on host specificity for most species of the group.

#67

MALE ABDOMINAL BRUSH ORGANS IN THE GRAPHOLITA-PAMMENE COMPLEX (LEPIDOPTERA, TORTRICIDAE). F. Komai (Environmental Planning Department, Osaka University of Arts, Osaka 585, Japan).

The Grapholta-Pammene complex is a monophyletic group in the Grapholitini of the Olethreutinae which consists of the following eight genera: Grapholita Treitschke, Pammene Hübner, Pseudopammene Komai, Dierlia Diakonoff, Parapammene Obraztsov, Mimarsinania Kocak (=Diamphidia Obraztsov), Andrioplecta Obraztsov, Strophedra Herrich-Schäffer (Komai, unpublished). One of the supposed autapomorphies of the complex is the presence of a pair of hair pencils between the abdominal segments VIII and IX. The organ is made of the following three elements: 1) abdominal sternite VIII which becomes smaller and is modified in the form of semicircle or crescent; 2) ventral sclerite on intersegmental membrane between segments VIII and IX which is tucked in the abdomen; 3) a pair of scale-tufts which is situated on pleural area near the proximal ends of the lateral processes of the intersegmental ventral sclerite. Of these elements, the scale-tufts often reduce or disappear in the level of genus, species-group, or species. In accordance with the degeneration, a transverse patch of scales or a pair of scale-tufts appears on the anterior portion of the abdominal tergites (IV-VIII). In most species of Parapammene a transverse patch of hair-like or narrow scales and of modified black scales are present on the tergites IV and V, respectively. In Pammene a transverse patch of scales is situated along the anterior edges of the tergites VI to VIII. In Pseudopammene, Strophedra, and some species of Andrioplecta, a pair of scale-tufts arises from membranous shallow pockets formed in the anterior corners of the eighth tergite.

#68

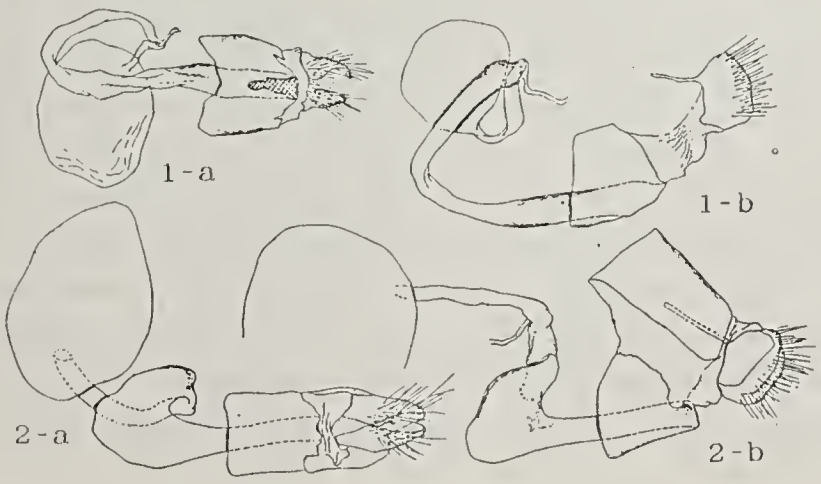
Biclogical survey of the Iranian sub species ostrinia nubilalis H.B.N. in the eastern part of Mazandaran during the years of 1988 to 1990
B.Amiri - Agricultural sciences Sari Iran.

A Method is based on light trap data during the year and rearing the insect in laboratory.
The persian strain of this insect ostrinia nubilalis persica (Mutuure - and Munroe) has morphologic and biological differences with its European kind.
Its size is smaller than the European one.
sacculus part of male genitalia in Iranian sub species is different from the European one the Iranian sub species of ostrinia nubilalis showed 3 perfect generation and one incomplete winter generation in 1989 and 1990.
This pest overwinters as complete larve formed in the stem of the corn and the weeds of the near by fields.
The Iranian sub species of ostriniashowed host preference for xanthium stramarium among the weeds.

#69

WHAT IS "KALLIMA INACHUS"? Akinori Nakanishi (Museum of Human and Nature, Hyogo, Japan)

"Kallima inachus" widely distributed from Japan (Okinawa) through Kashmir is one of the best known leaf-butterflies of the world. During the course of revisional study of the genus Kallima I have found that "Kallima inacus" is not a homogeneous species and comprises two closely allied good species. The differences between these two species are most clearly represented by the female external genitalia as shown in Figs. 1-2.



#70

GENETIC ANALYSIS OF A CONTACT ZONE OF *PONTIA DAPLIDICE* (LINNAEUS 1758) AND *P. EDUSA* (FABRICIUS 1777) (LEPIDOPTERA: PIERIDAE). Remo Wenger, H. J. Geiger, A. Scholl and M. Zimmermann (Institute of Zoology, Department of Population Biology, University of Berne , Baltzerstrasse 3 CH-3012 Berne, Switzerland)

Our previous electrophoretic studies have indicated two genetically distinct parapatric taxa within the nominal *Pontia daplidice* L. in southern Europe. These taxa differ in allele substitutions at four out of 24 enzyme loci surveyed. Furthermore, analysis of adult morphology revealed differences in the shape of valvae and in the colour of the forewing underside, with slight overlap between both taxa. Laboratory studies indicated no premating but strong postmating barriers. Wagener (1988) ranked these taxa as semispecies. We showed that the western European taxon (*daplidice* L., sensu Wagener, 1988) flies in France, Spain, on the Canary Islands, in Morocco and Israel and Turkey, whereas the eastern European taxon (*edusa* Fabricius, sensu Wagener 1988) is found in Switzerland, Italy, (including Sicily and the Tyrrhenian island Corsica), Austria, Yugoslavia, Hungary and Greece and Turkey.

We continued our studies on the distribution of both taxa, with particular emphasis on contact zones. As we show, the western taxon extends east beyond the Alpes Maritimes into northern Italy. Both taxa meet north of the Ligurian Alps where we found a rather narrow hybrid zone which is less than 40 km in width. Within this hybrid zone both F_1- and backcross hybrids are observed in low numbers. However, in spite of the fact that these butterflies are considered medium distant migrants, there is no evidence of gene flow beyond the hybrid zone.

References:
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Wagener, P.S., 1988: What are the valid names for the two genetically different taxa currently included within *Pontia daplidice* (Linnaeus, 1758) ? (Lepidoptera: Pieridae). Nota lepid. 11: 21-38.

#71

A NEW SPECIES AND THREE NEW SUBSPECIES ON THE GENUS BHUTANITIS. Dianfu Hou (Hunjiang Municipal Committee for Science and Technology, Hunjiang, Jilin 134300, China)

The genus Bhutanitis named by Atkinson are all rare species listed as grade R conserve animals. Since the record of B. thaidina Blanchard in 1871, the first record of the genus Bhutanitis, 4 species, B. thaidina, B. lidderdalei Atkinson (1873), B. mansfieldi Rily (1939) and B. ludlowi Gabriel (1942), and 2 subspecies, B. m. pulchristriata Saigusa et Lee (1982) and B. t. dongchanensis Lee (1985), had been reported by 1989. In this paper, the author presents detailed descriptions of the morphological and genital characters of a new species, B. jiayinae sp. nov., and 3 new subspecies, B. j. zhongdianensis subsp. nov., B. t. trimaculatus subsp. nov., B. m. dahuoshanensis subsp. nov., found in Hengduan Mountains, southwest China. The above species or subspecies excluding B. ludlowi and B. lidderdalei can be only found in China. Of the 10 species or subspecies, 4 had been studied on the life history, ecology and the rearing method.

#72

STUDIES ON THE LIFE HISTORY AND ECOLOGYOF THE SUBSPECIES BHUTANITIS MANSFIELDI DAHUOSHANENSIS. Dianfu Hou (Hunjiang Municipal Committee for Science and Technology, Hunjiang, Jilin 134300, China)

Adult: Univoltine, occurring from late-April to mid-May, flying in fine days from 12:30 to 17:00, preferred to feed honeydew of the plant family, Ericaceae. Flying stopped when temperature is lower that 15℃ or it is overcast or rainy. Once emergence, adults aggregate. The period of mating lasted 1 week. After mating, female adults laid eggs on the back of host plant leaves.

Egg: 1.38 mm diameter, 1.09 mm in height, semispherical. Its color changes from slight milky-yellow and translucent to orange and then to black with the coming of hatching. Egg-stage lasted about half a month.

Larva: feeding on leaves of Aristolochia sp. only. Newly hatching larva was brownish and translucent. Beginning in the second instar, one pair pf the lateral dorsal tubercles present red-orange color, without dorsomeson and subdorsal lines. The first two instars are gregarious. The length of the mature larva is 2.6-3.2 cm. The rate of head/body is higher than that of B. thaidina. Y-Gland is shorter and orange.

Pupa: Differ largely from B. jinyinae, and similar with B. mansfieldi and B. m. pulchristiata. B. nigrilima Hou. Overwinter through girdle-type pupa. The silky tail-pad is dark brown.

#73
JUVENILES AND PHYLOGENETICS OF THE ITHOMIINAE, HELICONIINI, AND PAPILIONIDAE (LEPIDOPTERA): TOWARDS AN OPTIMAL NATURAL CLASSIFICATION. Keith S. Brown Jr., Clécio F.Klitzke, André Victor Lucci Freitas & Paulo César Motta (Dept? Zoologia, Inst. Biologia, UNICAMP, C.P. 6109, Campinas, SP 13.081, Brazil).

An experimental (field and laboratory)/field population approach to the natural classification of highly diversified insect groups was developed and applied to three Neotropical butterfly taxa. As many different manifestations of the genome as possible were used, including study of secondary chemicals, but not DNA or isoenzymes which are being examined independently in other laboratories. Large polythetic matrices were produced, with 30 to 50 taxa representing all presumed divergent (and often speciose) radiating lines in each group, with at least 200 character state changes distributed between juvenile morphology, chemistry/behavior, and adult morphology (no more than 40% in each category). Characters already used by others were reanalyzed, recoded, and corrected where necessary, and combined with new characters developed from rearing juveniles and field study of each taxon. The states were polarized using a series of presumed or functional outgroups with minimal apomorphy. The phylogenies thus produced showed acceptable consistencies and represented suggestive and novel arrangements of the taxa. Some groupings were very stable to modification of characters in the matrices, while others were labile to the change of even a single character, indicating characters and taxa with special interest for further evolutionary study; some of these were looked at more closely by artificial hybridizations or transects across hybrid zones in the field.

#74
TAXONOMICAL STUDIES ON FLIES IN SOUTH KOREA. Soung-Ho Park(Dept. Biol.,Teacher's College,Kyungpook Nat. Univ.,Taegu 702-701,South Korea) and Tae-Ho Jo (Dept. Biol.,Chinju Nat.Teacher's College, 380 Sinandong,Chinju,Kyeongnam 660-756,South Korea)

A total of 122 species of flies collected in South Korea since 1919 is described,which consists of the collections by Kobayashi,Hori and the authors

They include 25 species belonging to 15 genera of the family Calliphoridae, 42 species belonging to 17 genera of the family Sarcophagidae and 55 species belonging to 20 genera of the family Muscidae.

#75
SYSTEMATIC STUDY OF THE TRIBE LIMONIINI MAINLY BASED ON MALE AND FEMALE TERMINALIA (DIPTERA, TIPULIDAE, LIMONIINAE). Takashi Torii (Department of Natural History, Faculty of Science, Tokyo Metropolitan University, Minamiohsawa, Hachioji, Tokyo, 192-03, Japan).

The Limoniini, a tribe of the subfamily Limoniinae, consists of several primitive tipulid genera.
This tribe includes the genera *Antocha*, *Dicranoptycha*, *Elliptera*, *Helius*, *Limnorimarga*, *Limonia*, *Orimarga* and *Thaumastoptera* . They are small to medium sized Tipulidae, with 12 or 14 flagellomeres of antenna and relatively simple terminalia in both sexes, about 130 species are known of Japan.

Following characters are mainly studied, if possible, each character state assumed to be apomorphic or plesiomorphic. [Male terminalia]: structure of both gonostyli; mesal part of gonocoxite; basal ring; tg.9 division; caudal margin of tg.9; internal sclerite attached to tg.9; st.9 division; caudal half of st.9; aedeagal sheath; structure of both branches of paramere; interplate connecting two inner branches of paramere; gonocoxal apodeme; interbase; sclerite connecting both gonocoxal apodemes; tip of aedeagus; sperm duct in base of aedeagus. [Female terminalia]: structure of cercus & hypogynial valve; dense pencil of long yellow setae on either side of tg.10; caudal half of st.8; number & sclerotization of spermatheca; structure of st.9 & st.10. [Wing]: Sc_2; R_2; origin of Rs; m-m; basal section of CuA_1; anal angle; pale fold in cell cua_2; macrotrichia distribution.

By the above characters, the Tribe Limoniini is divided into several genus groups. Additionally, affinity and phylogeny are discussed on the genera belonging to the Tribe Limoniini.

#76
A TAXONOMIC STUDY OF THE SUBGENERA OF ADLERIUS AND LARROUSSIUS (DIPTERA:PSYCHODIDAE). M.A.Seyedi Rashti,(Department of Medical Entomology and Vector Control,School of Public Health,Teheran University of Medical Sciences,P.O.Box.6446-14155,Teheran ,IRAN).

Identification of sand-flies are based mainly on the structure of head,male and female genitalia and different indices (phlebometry). During this study sand-fly species collected from differentcountries of Middle East were examined.Charaters for identification were investigated and some structures were measured.The results of this study showed that some of the quantitative characters are so variable in some species that one cannot decide about the species on the basis of some measurements.

The results of measurement for some species are as follows:

Species	A3 ♂	Labrum	Coxite	Style	Laburm♀
arabicus	370-430	250-300	320-450	170-200	320-410*
balcanicus	340-430	290-300	400-450	180-240	320-400
halepensis	380-440	270-310	300-410	180-210	370-380
longiductus	280-470	240-300	380-450	170-250	310-390
simici	230-290	200-250	250-320	130-150	250-300
kandelakii	260-350	200-320	270-300	130-150	280-300
keshishiani	300-570	230-380	370-470	170-250	300-380
longicuspis	320-310	200-250	300-320	100-150	250-300
orientalis	250-370	180-240	290-400	140-200	290-300
perfiliewi	230-350	200-260-260-360		150-160	320-380

* in micron. A3=Third antennal segment

#77
TAXONOMIC STATUS OF SPECIES *AEDES CASPIUS* PALLAS, 1771 AND *AEDES DORSALIS* MEIGEN, 1830 (DIPTERA. CULICIDAE) IN PANONIAN BASIN (EUROPE). B. Bozicic-Lothrop, D. Radovic, Ante Vujic, Lj. Vapa (Institute of Biology, Trg D. Obradovica 2 21000, Novi Sad, Yugoslavia)

Species *Aedes dorsalis* originates from Central Asia and has a distribution all over Holarctic, right down to Mexico. Its habitats in Europe are found in salty lakes and marches of the continental regions. Species *Aedes caspius*, with a narrower distribution (Palearctic), is characteristical for Mediterranean zone in Europe. These two species have overlapping area regions in Panonian Basin where their populations have been examined for the purpose of their taxonomic status determination. Previous researching works dealt with a great morphological heterogeneity. Morphological analysis has revealed a large number of intermediary forms, classified into several basic types.

Our researching covered several localities in Vojvodina (Yugoslavia). The material was collected in larval stage and each individual form was separately raised up to the time of flying out. In this way it was possible to analyze morphologically every single individual at each developmental stage. It was also possible to examine genetic variability in the population of these two species applying polyacrylamide gel electrophoresis isosims and by means of genetic closeness (I) and distance (D) of taxa of *Aedes caspius* and *Aedes dorsalis*.

#78
SOME REMARKS ON SYSTEMATICS OF "SYNDIAMESA" JACUTICA TSHERN.(DIPTERA,CHIRONOMIDAE) FROM RUSSIA. I.E.Kerkis (Department of Natural Sciences, Novosibirsk University, 630090 Novosibirsk, Russia), E.A.Makarchenko (Institute of Biology and Soil, 690022 Vladivostok, Russia).

Syndiamesa jacutica was named by Chernovski (1949) however the first description of larvae morphology was published by Zvereva (1950) in Diamesinae. The morphology and karyotypes of the larvae of Tokunagayusurika akamushi (Tok.) from Japan, China and Syndiamesa jacutica from West Siberia were studied. It was established, that these larvae are identical. So, it means S.jacutica is a synonyme of T.akamushi from Orthocladiinae. The first description of karyotypes of T.akamushi from China and West Siberia is presented. Based on the results of metaphase chromosome analysis, T.akamushi has a diploid number of 6

#79
A PRELIMINARY TAXONOMIC STUDY OF THE GALL MIDGES (DIPTERA: CECIDOMYIIDAE) FROM CHINA *Xin-pei Jiang* (Chongqing Animal and Plant Quarantine , Chongqing , 630020, China).

This paper deals with , for the first time, the taxonomy of the gall midges (Diptera : Cecidomyiidae) from China . 35 genera and 58 valid species belonging to all three subfamilies of the family Cecidomyiidae are concerned in this paper . There are 9 species new to science , 1 species , *resseliella quadrifasciata* (Niwa , 1910), as a new combination , and 9 genera and 13 species reported as new records from China . Specimens studied were collected from various areas of China by the author and others anddeposited in the Insect Collections of Chongqing Animal and Plant Quarantine Service .

#80
A TAXONOMIC STUDY ON GALL MIDGES (DIPTERA: CECIDOMYIIDAE) FROM CHINA. Wen-jun Bu (Department of Biology, Nankai University, Tianjin 300071, China)

The taxonomy of Chinese Cecidomyiidae is poorly studied. Up to now, only 32 species of gall midges which have been definitely identified to the species level were recorded from China. Besides these, there are some species of economic importance have been reported with only their generic names identified.

In this study, a total of 113 species belonging to 46 genera of Chinese gall midges are reported, in which 47 species are new to science, 34 species and 28 genera are new records to this country. Of these species, only the adult stage are studied, not inclusing their immature stages. A description of the gall is given when the materials are available. The type specimens of new species will all be deposited in the Department of Biology, Nankai University. The materials used in this work wre mostly collected from the representative areas all over China in recent years, by the author himself and the other staff members of the Department. More than 2500 mounted slides were examined in this study.

#81
OBSERVATIONS ON THE EMPIDIDAE OF THE BREITENBACH, A SMALL CENTRAL EUROPEAN MOUNTAIN STREAM. Wagner, Rüdiger and Gathmann, Oliver (Limnologische Flußstation Schlitz des Max-Planck-Instituts für Limnologie, P.O. Box 260, DW-6407 Schlitz, Germany)

34 species of dance flies with aquatic larval and pupal development (Empididae: Clinocerinae and Hemerodromiinae) were recorded from the Breitenbach. Most species were members of the subfamily Hemerodromiinae (genera Chelifera and Hemerodromia). Most species were univoltine, with the exception of Chelifera pyrenaica Vaillant, which was univoltine in the vicinity of the stream's spring, but had two generations in the lower reaches of the stream. Population densities were always lower near the spring, and increased down-stream. Males of all species were significantly smaller than females, and in individual years the size of females and males showed clear patterns along the stream. Specimens emerging in the vicinity of the spring were significantly larger than those from the lower reaches. Clinocerinae were comparatively rare. However, three species from the genera Wiedemannia and Dolichocephala showed a dramatic increase in numbers between 1985 and 1990 in the middle and lower reaches. The reasons for this remain unclear because of our limited knowledge of the larval ecology.

#82
DISTRIBUTION OF THE GENERA DOLICHOPODIDAE (DIPTERA) OF THE WORLD FAUNA. Negrobov,O.P. (Voronezh State University, Universitetskaja pl. 1, 394693, Russia).

At present 183 genera and more than 5300 species of the family Dolichopodidae are known in the world fauna. The subfamily Dolichopodinae (more than 1300 species) and the subfamily Sciapodinae (more than 1000 species) are most numerous in species. Two species of Dolichopodidae are typical cosmopolitan and 14 genera have worldwide distribution. Nearly 150 species are recorded for two and more biogeographic regions and subregions. The Paleearctic fauna resembles the Nearctic fauna but these faunas weren't compared. The names of the biogeographic subdivisions of the world fauna are given according to Tachtadjan (1978).

#83
THE FAMILY *PIPUNCULIDAE* (*DIPTERA*) IN MONGOLIA. Milan Kozánek, (Institute of Experimental Phytopathology and Entomology SAS, 900 28 Ivanka pri Dunaji, CSFR).

The material of Mongolian *Pipunculidae* from Hungarian Museum of Natural History forms the basis of this study.

At present 32 species belonging to 5 genera have been recorded from Mongolia, including 2 new species, and 8 species new for Mongolian fauna. The description of new species is given, and check list of all recognized species is presented. The data are commented from zoogeographical point of view.

#84
REVISION OF THE AFROTROPICAL SPECIES OF IOMOSVARYELLA ACZEL (DIPTERA, PIPUNCULIDAE). Marc De Meyer, Dept Zoology, Moi University, Eldoret, Kenya.

Pipunculidae (Diptera) are small inconspicuous flies, closely related to hoverflies (Syrphidae). Approximately 900 species are known worldwide, of which about 140 occur in the Afrotropical region.

The Afrotropical representatives of the genus Iomosvaryella Aczél were revised, with detailed (re)descriptions and illustrations of the male and female genital structures. Their relationship and affinities with European representatives are discussed.

#85

COMPARATIVE IMPORTANCE OF TAXONOMICAL CHARACTERS IN CLEARANCE OF PHYLOGENETIC RELATIONS WITHIN THE GROUP OF HOVER FLYES (DIPTERA: SYRPHIDAE). S. Glumac, and A. Vujic (Institute of Biology, University of Novi Sad, 21000 Novi Sad, Yugoslavia)

A whole spectar of analysis is needed to clear up phylogenetic relations within a heterogenous group of insects. The hover flyes (Diptera: Syrphidae) certainly belong to such a group with a high heterogeniety of morphological forms, developmental forms and ecotypes of larvae. Adult forms also characterize with a great diversity. The paper is an attempt to present the importance of comparative taxonomic characters through already established relationships, ways of and possible evolutional directions of this group.

#86

STUDY ON THE GENUS *HELOPHILUS*(DIPTERA:SYRPHIDAE) FROM CHINA. Qing-xi Li (Lab. of Insect Ecology,South China Agricultural University, Guangzhou,510642, China)

The paper dealt with the genus *Helophilus* from China, and 8 species have been recorded to the present time,including 5 species which are new to China: *H.*(*H.*) *bengalensis* Wiedemann, *H.*(*H.*) *hybridus* Loew, *H.*(*H.*) *pendulus* Linnaeus, *H.*(*Parhelophilus*) *frutetorum* Fabricius, and *H.* (*Anasimyia*) *transfugus* Linnaeus. The descriptions and distributions of these species were also provided in the paper.

#87

A STUDY ON DROSOPHILA (DIPTERA: DROSOPHILIDAE) FROM WUHAN CHINA. Yuan-huai Qian, Jing Zhang, Qing-tao Zeng, Xiao-giao Xue (Department of Biology, Hubei University, Wuhan 430062, China)

113 apecies of Drosophila are reported from Wuhan, China. These species beiong in 12 genera and 2 subfamily of Drosophilidae. It's genera and numbers of species as follows:

I. Subfamily steganinae (26)

1.Amiota	(9)	3. Leucophenga	(14)
2.Cacoxenus	(2)	4. Paraleucophenga	(1)

II. Subfamily Droaophilinae (87)

5.Chymomyza	(1)	9. Mycodrosophila	(1)
6.Dettopaomyia	(2)	10. Paramycodrozophila	(2)
7.Drosophila	(69)	11. Seaptomyza	(9)
8.Drosophiletta	(1)	12. Zaprionus	(2)

In this paper, 100 species are first reported in Wuhan, China.

#88

BIOCHEMICAL PHYLOGENY IN THE SIXTEEN SPECIES OF THE SUBGENUS DROSOPHILA. Taek-Jun Lee, Eun-Suk Song(Department of Biology, Chung-Ang University, Seoul, KOREA)

Phylogenetic relationships among sixteen species of the subgenus Drosophila in Korea were investigated by starch gel electrophoresis(SDE) and two-dimensional electrophoresis(TDE). It was evidenced that both electrophoretic techniques are adjunctively useful tools in taxonomy. Although the magnitude of genetic differentiation may be different between allozyme loci obtained by SDE and protein loci surveyed by TDE. The biochemical dendrograms in the subgenus Drosophila were constructed by the data sets(SED and TDE) of genetic distance between species. These species can be divided into two phyletic groups, one comprises the virilis, robusta and melanica species groups, while the other includes the quinaria, bizonata, testacea, histrio and immigrans species groups. The genetic relationships were consistent with the results of cluster and cladistic analyses for 30 morphological characters among the sixteen species.

#89

COLD-HARDINESS OF CHYMOMYZA COSTATA (DIPTERA; DROSOPHILIDAE). Ari J. Riihimaa (Department of Genetics, University of Oulu, 90570 Oulu, Finland.)

It was shown earlier that diapausing third (final) instar larvae of Chymomyza costata become freeze tolerant after one month acclimation to 4°C. Their lower lethal temperatures (LLT50) were extended to temperatures below -80°C provided that freezing of body tissues was started by inoculation at near zero temperatures and the cooling rate was slow (0.1°C/min). Here I report on experiments with post-diapause larvae, pupae, and adults done with the same method. The strain used was started from flies collected from Finland, Oulu (65°N). The results were as follows: The LLT50 of larvae tested immediately after transfer from overwintering conditions (4°C) to 16°C was well below -28°C (the lowest temperature used). During the time period of about 10 days preceeding pupation at 16°C, the LLT50 of the larvae increased gradually to about -18°C. The LLT50 of pupae of different ages was about -16°C. The LLT50 of adult flies was about -9°C.

#90

CHARACTERISTICS OF TACHINID FAUNA (DIPTERA, TACHINIDAE) IN YUNNAN PROVINCE, CHINA. **Hiroshi Shima** (Biological Laboratory, College of General Education, Kyushu University, Fukuoka, 810 Japan) and **Zhang Wenxia** (Kunming Institute of Zoology, Academia Sinica, Kunming 650107, China)

On the basis of the collections of our own field research in Yunnan (1989, 1990) and of Kunming Institute of Zoology, Kunming, the characteristics of tachinid fauna in Yunnan Province are considered.

The family Tachinidae is classified into 4 subfamilies in recent tachinid systematics (e.g., Herting, 1984). The 4 subfamilies in Yunnan are different from each other in faunistic compositions but are totally recognized to contain the following components in generic level: many genera with the Oriental and Sino-Japanese (or East Asiatic) distribution, some Palearctic and a few cosmopolitan. The subfamily Phasiinae in Yunnan mainly contains genera with Oriental distribution, the tribe Dexiini of the subfamily Dexiinae is composed of genera with Palearctic distribution, and the tribe Voriini of the subfamily Dexiinae is characteristic in containing many genera with Oriental distribution. Two large subfamilies, Tachininae and Exoristinae, are mainly composed of East Asiatic and cosmopolitan genera, but they contain many endemic species or species with Sino-Japanese distribution. The endemic species in each subfamily seem to be most dominant in the fauna and followed by species with Sino-Japanese or east Asiatic distribution. Despite the geographical position, the tachinid fauna in Yunnan Province seem to have close relationships to the Japanese fauna. It is expected that the research on the host-parasite relationships will reveal the faunistic characteristics of Yunnan tachinids more accurately.

#91
THE FIRST REPORT ON CHLOROPIDAE (DIPTERA) OF VIETNAM. E.P.Nartshuk, (Zoological Institute Academy of Sciences, S.-Petersburg, 199034 Russia).

51 species of Chloropidae are identified in the material collected in Vietnam 1986-1989. Only 6 species have been known previously from the country. Known Vietnamese species belong to Siphonellopsinae - 1 genus, 1 species, Rhodesiellinae - 2 genera, 6 species, Oscinellinae - 15 genera, 28 species and Chloropinae - 10 genera, 16 species. 12 new species are described in genera Rhodesiella (1), Polyodaspis (2), Calamoncosis (1), Siphunculina (1), Tricimba (1), Conioscinella (1), Dicraeus (2), Ensiferella (2) and Thressa (1). Four faunal elements are recognized according distributional patterns of known species: 1) spread in Oriental and other regions - 7 species, 2) widespread in Oriental Region - 14, 3) east-oriental species (from Ryukyu across Taiwan, Vietnam, Malaya, Java) - 16, 4) known only from Vietnam - 13 species. Number of species and specimens are the largest in Oscinellinae and Rhodesiellinae in comparison with Chloropinae. Such pattern is peculiar to tropical fauna of Chloropidae. The Vietnamese fauna of Chloropidae differs strongly from the Chloropidae fauna of India.

#92
RESUMPTION OF THE GENUS SINODACUS (DIPTERA:TEPHRITIDAE). Xiao-lin Lin (Guangzhou Animal and Plant Quarantine Service, Guangzhou 510010, China), You-shin Chao (Institute of Plant Quarantine, Ministry of Agriculture, Beijing 100026, China)

The genus Sinodacus was created by Zia in 1936, the type-species was S. hochii Zia (♂) and it's locality was Hainan, China. The position of Sinodacus has been changed since then. Hering (1952) treated it as a subgenus of genus Callantra. Hardy and Adachi (1954) included it in subgenus Strumeta (Bactrocera was resumed in 1976 instead of Strumeta, which is treated as a synonym of Bactrocera), under genus Dacus. Hardy (1977) considered Sinodacus as a subgenus of Callantra. Munro (1984) elevated Dacinae to Dacidae and treated Sinodacus as a genus of Callantrae. Drew (1989) divided Dacini into two genus, viz. Bactrocera and Dacus; and treated Sinodacus as a subgenus of Bactrocera, Callantra as a subgenus of Dacus. It is obvious that Sinodacus has been put in an unstable position between Callantra and Bactrocera since 1952.

The authors have studied 40 specimens of Sinodacus(including 6 species), which were collected in China, and consider that Sinodacus does not belong to Callantra or Bactrocera, should be resumed as a separate genus.

Some more characters of genus Sinodacus are supplemented in this paper on the basis of the authors' studies.

#93
STUDY OF FRUIT FLIES (DIPTERA: TEPHRITIDAE) IN THE PALAEARCTIC FAR EAST. Valery A. Korneyev (Institute of Zoology, Ukrainian Acad. Sci.,Lenin str. 15,252650 Kiev-30 GSP, Ukraine)

Since Matsumura (1916), Shiraki (1933) and Zia & Chen (1938-1947) began their study of Tephritids, ca, 400 nominative species of more than 125 genera had been described up to recent time, The most valuable contributions were done by Hering (1936-1953) and Ito(1947-1985); the latter has proposed exact generic subdivision for Trypetini of the Far East. Further studies of Kwon (1985), Wang (1988-1990) and Korneyev (1987-1991) added more new taxa and became the base for taxonomical revisions those allow us to replace and synonymize several species and genera.20 species from 10 genera of Acanthonevrinae (incl.Phytalmiini), 11 species (2 genera) of Adraminae, respectively 12 (6)of Ceratitinae(incl.Gastrozonini),16(8) of Dacini, 146 (53) of Trypetinae and 147 (40) of Tephritinae (incl. Myopitini) have been recorded for the Eastern Asiatic Region and east of the Angaric Region of Palaearctics. The most number of endemic genera belongs to Trypetini s.str. Several genera such as Vidalia, Trypeta, Whiteina, Tephritis need further taxonomical revisions.

#94
Revision of the Genus *Eurosta* Loew, with a Scanning Electron Microscopic Study of Taxonomic Characters (Diptera: Tephritidae) Yue Ming* and William J. Turner, Department of Entomology, Washington State University, Pullman, WA 99164-6432 U.S.A.

Members of the genus *Eurosta* Loew (Diptera: Tephritidae) make stem, crown or root galls on goldenrod plants (Asteraceae: *Solidago* L.). Herein seven species are recognized: *E. comma* Wiedemann, *E. cribrata* (Wulp), *E. fenestrata* Snow, *E. floridensis* Foote, *E. lateralis* (Wiedemann), *E. latifrons* (Loew) and *E. solidaginis*. The names *E. reticulata* Snow and *E. conspurcata* Doane, are synonymized with *E. cribrata* (Wulp) which is removed from synonymy with *E. latifrons*, and a third, *E. elsa* Daecke, is synonymized with *E. comma* (Wiedemann). Two subspecies of *E. solidagenis*, ssp. *solidaginis* (Fitch) and spp. *fascipennis* Curran, are redescribed and illustrated.

External structures of eggs, larvae, puparia and adults were examined with the scanning electron microscope and their taxonomic importance is evaluated. Two species groups are recognized on the basis of morphological, and biological characteristics.

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#95
LINKS OF SOME TAXONOMICAL CHARACTERS (WING VENATION, COLORATION, ETC.) OF HYMENOPTERA WITH HABITAT. Tobias, V.I. (Zoological Institute, Russian Acad. Sci., St. Petersburg, 199034, Russia).

According to Danforth (1989), trends to proximal shift of wing venation in the Hymenoptera correlates with decrease of body size and distal extension of wing vein elements with its increase. In the cited publication, however, dependence of such displacements in arid or humid ecological conditions, known for the Braconids (Tobias, 1959, 1966, 1977), is ignored. The same trends are found in Ichneumonidae, Sphecidae, Pompilidae, Apoidea. The proximal shift is clearly seen in species living in arid regions (steppes, deserts). Conversely, in those species that live in humid habitats, under forest canopy, a trend to distal displacement of wing venation is revealed. In evolutionary aspect the proximal shift is explained by action of wind in open landscapes, and the distal displacement is a consequence of the absence of wind in the forest. At the same time in definite equal ecological conditions correlations of the venation shifts according to decrease or increase of body size is confirmed. Species living in arid often have also light colouration of the body or very variable colouration, depigmented wing membrane and pubescence and weakly developed sculpture.

#96
CHINESE SAWFLIES (CIMBICIDAE, HYMENOPTERA, SYMPHYTA). Xiao-yun Huang, Shu-zhi Zhou and Zhen Zhang (Research Institute of Forestry, Chinese Academy of Forestry, Beijing 100091, China)

There are 130 known species of Cimbicidae in the world which composed of 4 subfamilies and 19 genera. At present 39 species belonging to 9 genera are found in China. In this paper, 7 genera and 29 species are described, including 3 new species, Trichosoma pseudosaribi Huang, Clavellaria beijingensis Huang and Abia hainanense huang. The larvae attack Rosaceae, Salicaceae, caprifoliaceae and so on. The species of Cimbicidae have showed high economic value.

#97

DISCOVERY OF A SYMPATRIC HOST RACE FORMATION ZONE AND THE MECHANISM OF SPECIATION IN THE FERN SAWFLY *Hemitaxonus japonicus*. Chikahiko Naito (Faculty og Agrieulture Kobe University, Rokko, Kobe 657, Japan), Akira Tai (Faculty of Seience, Himeji Technologieal College, Kamigori-cho, Ako-gun 678-12, Japan)

Hemitaxonus japonicus is a very rare example that sympatric host race formation is now in progress in the field. This univoltine sawfly is distributed from Hokkaido to the northern part of Kyushu, Japan, and assoeiated with *Polystichum tripteron* and *P. polyblepharum* whieh coexist sympatrieally. Two reproductively isolated host raees oeeur sympatrieally and synchronieally in the areas north of around lat. 34°N while an oligophagous population feeding on both plants is distributed in the areas south of the latitude. The new host raee, *polyblepharum* race is being formed within about 10km between these two areas without geographieal isolation, where the host preference and ability of larval survival rapidly ehange. Four major faetors for deproductive isolation may effeetively aet one another in the emergenee and maintenanee of the new host raee: (1) disruptive host selection controlled by two alleles at a single locus, (2) assortative mating with respeet to host preference, (3) asymmetrieal mating to prevent the gene flow from the original host race population to the new one, (4) larval mortality of the new host raee on the original plant due to conditioning to the new plant.

#98

PARASITOIDS (HYM., BRACONIDAE) FROM FRUIT FLIES (DIP., TEPHRITIDAE) IN BRAZIL. Zucchi, R.A.,F.L. Leonel Jr. (Department of Entomology, ESALQ, 13400 Piracicaba, São Paulo, Brazil).

Parasitoid species were collected from fruit fly puparia in 26 host fruit species. The host fruits were sampled during 13 months in two municipalities of the State of São Paulo. Also, samples from other Brazilian localities were received for studying. A total of 3,525 braconids belonging to the subfamilies Opiinae and Alysiinae were examined. The specimens of the subfamily Opiinae were the most common ones. They belong to the following species: *Doryctobracon areolatus* (Szépligeti, 1911), *D. brasiliensis* (Szépligeti, 1911), *Opius bellus* Gahan, 1930 and *Utetes (Bracanastrepha) anastrephae* (Viereck, 1913). Concerning the genus *Opius*, a few specimens most closely resembles *bellus*, but differ by having pale hind tibiae. The identity of these specimens was not clarified so far. In the subfamily Alysiinae, the unique species collected was *Phaenocarpa anastrephae* Muesebeck, 1958 (first record in Brazil). *D. areolatus* was the predominant species (74% of all specimens collected) and had a wide geographical distribution. It was obtained from fruit fly puparia in about 95% host fruit species. Besides braconids, 46 specimens of Cynipidae, Eucolinae and 6 of Diapriidae were also collected. The parasitoids were collected mostly from puparia of *Anastrepha* species and/or *Ceratitis capitata* (Wied., 1824). However, excepting *P. anastrephae*, all the other braconid species were also collected from puparia of *Rhagoletotrypeta* sp. (first reference).

#99

APHELINIDAE - PARASITOIDS OF THE DIURAPHIS NOXIA MORDVILKO FROM UKRAINE. Oksana V.Chervonenko (Institute of Zoology Ukrainian AS, 252601,Kiev)

Biological control of Diuraphis noxia - one of the key pest of wheat and grain, has received considerable attantion in the recent year. A survey of aphidophagous species of Aphelinidae in major grain-produsing counties of Ukraine revealed the primary parasitoids Aphelinus toxopteraphidis Kurd, A.varipes Forst.,A.chaonia Walk.&A.kurdjumovi(Merc) Secondary parasites were represented by Alloxista sp.,Dendrocerus sp.,Pachyneuron sp. Parasitoid activity was not significant during mid-season when D.noxia is capable of rapidly exceeding the economic threshold level. The hyperparasitoids are usualy rare at the beginning of the season and may parasitize 30-40% of the primary parasitoids in moment when the aphis population crush. The impact of aphelinids on D.noxia populations can be determined separately from the actions of other groups of parasitoids.

#100

THE ANT FAUNA OF THE ORIENTAL REGION: AN OVERVIEW (HYMENOPTERA, FORMICIDAE). Kazuo Ogata (Institute of Tropical Agriculture, Kyushu University, Fukuoka 812, Japan)

The current status of the ant taxonomy in the Oriental region is overviewed. In sipite of the recent progress of myrmecology, the outline of ant fauna of the Oriental region is obscure. The present confusion comes from (1) isolate descriptions without appropriate comparison; (2) obscure definition of higher taxa; (3) unreliable "infraspecific variations". Current taxonomic works try to revise taxa based on comprehensive material collected by various techniques. As a result, the number of genera has been reducing due to synonyms but that of species has been increasing in spite of synonyms.

The number of species of the Oriental region are estimated more than 3,000, belonging to 132 genera of 10 subfamilies. At genus level, 35 of those are endemic to this region. The Oriental and the Australian regions share 77 genera in common, which represents 47 % of total number in both regions and is the highest ratio of common genera with other regions.

#101

STRUCTURE OF ANT COMMUNITIES IN EAST ASIA: REGIONAL DIFFERENCES, SPECIES-AREA RELATIONS, AND DIVERSITIES. Mamoru Terayama (Biological Laboratory, Toho Institute of Education. 1-41-1, Wakaba-cho, Chofu, Tokyo, 182 Japan)

Geographic patterns within community structure of ants were studied through the biogeographic method in East Asia.

Based on the distribution data of ants on 80 islands, in areas of Japan and Korea were classified into 4 major faunal types: Hokkaido, from Honshu to Yakushima Is. and Korea, the Ogasawara Isls., and the Ryukyu Isls., by means of the cluster analysis using a similarity index. The broad areas on the Japanese main Islands excluding Hokkaido were characterized as a transitional zone between the Palaearctic and the Oriental Regions. The species-area relations of insular ants in each faunal group fitted the power function model, $S = C \cdot A^Z$. Area diversity curves demonstrate low species diversity on the islands of the subarctic zene as compared with that in the temperate and the subtropical zones.

To compare the species diversity of ant communities, field studies were carried out in various forests in Japan, Korea, Taiwan, and Hong Kong. The diversity index values were the highest in the subtropical zone, and became smaller in the areas in high latitudes. The nest densities of ants in the subtropical rain forests were significantly higher than those in the temperate and the subarctic forests.

#102

THE PHYLOGENY OF THE FORMICIDAE AND ITS RELATIONSHIP TO OTHER ACULEATA.

HASHIMOTO Yoshiaki(Museum of Human and Nature, Hyogo Japan.)

Despite several excellent works on the phylogeny of the Formicidae, relationship of the formicid subfamilies remains uncertain. Phylogenetic analysis of organisms is essentially based on the information contained in their characters. A more accurate understanding of the formicid phylogeny still requires more knowledge on their characters. In this study, I tested hypotheses about the relationship of formicid subfamilies by new characters, such as the sensillum structures on the antennae and labial palpi, abdominal skeletomusculature and hind tibail structures.

These characters supported the following relationship of the formicid subfamilies:
(Formicinae + (Dolichoderinae + ((Myrmeciinae + Pseudomyrmecinae) + (Myrmicinae + (Ponerinae + Leptanillinae + Cerapachyinae + Dorylinae(s.l.))))))

Abdominal characters suggested Vespidae as the closest reative of Formicidae.

#103

SYSTEMATIC STUDY OF KOREAN LASIUS ANTS ON THE BASIS OF ELECTROPHORETIC DATA. Kim Byung-jin and Kyunghoon Im (Dept. of Molecular Biology, Wongkwang University, Korea)

Authors have classified Korean Lasius ants since 1981. Some of them have problems to be identified soundly according to only morphological characters. In order to solve them, this research was proceeded using electrophoresis. In this paper authors suggested some comparisons between morphological data and electrophoretical data. As a result, their phylogenic affinities are constructed by using clustering method.

#104

A CLASSIFICATION STUDY ON AMMOPHILINI FROM CHINA (HYMENOPTERA: SPHECIDAE). Li Qiang (Shandong Agricultural University, Shandong, 271018, China), Yang Chi-kun (Beijing Agricultural University, Beijing 100094, China)

This paper deals with the Chinese twenty-six species and subspecies belonging to the three genera Hoplammophila Beaumont, Podalonia Farnald and Ammophila Kirby of Ammophilini of Sphecinae, in which one species, Podalonia pilosa, is new to science and one is new to China. A key to the genera, species and subspecies is given. One of the widely scattered and abundant species in the northern China is A. sabulosa infesta Smith, rather than A. s. nipponica Tsuneki, but in the southern China is A. s. vagabunda Smith. In the faunal composition of Chinese Ammophilini, the palaearctic species occupy about 75%, oriental species 11%, and the species distributing both in palaearctic and oriental regions have about 14%. The wide distribution species occupy about a total of 42%, and endemic species have about 58%. The most of endemic species distribute only in a limited area in the north of China. A. s. infesta Smith and P. andrei (Morawitz) are representative species in the north of China, and A. s. vagabunda Smith is in the south of China. A. atripes atripes Smith is another main species of Chinese fauna, which widely distributes in most parts of China.

#105

EVIDENCE OF HYBRIDIZATION OF *BOMBUS ARGILLACEUS* AND *B. RUDERATUS* (HYMENOPTERA: APIDAE) IN A ZONE OF CONTACT IN FRANCE: ENZYME ELECTROPHORETIC DATA. Adolf Scholl, E. Obrecht and M. Zimmermann (Institute of Zoology, Department of Population Biology, University of Berne , Baltzerstrasse 3, CH-3012 Berne, Switzerland)

Among European bumble bees *Bombus argillaceus* Scopoli and *B. ruderatus* Fabricius show remarkable vicariance. *Bombus argillaceus* is found in southeast Europe and in northern Italy and extends west beyond the Alpes Maritimes. *Bombus ruderatus* is widespread in western and southern Europe. In the southeast of France both taxa show a rather broad overlap in the Alpes Maritimes and the Alpes Provençales. Species status of these taxa is not accepted by all authors, some regard them only as subspecifically distinct, and there has been considerable discussion among hymenopterists whether these taxa actually hybridize in zones of contact.

The main differences between *B. argillaceus* and *B. ruderatus* are wing color and coat color of the abdomen of queens. *Bombus argillaceus* queens have very dark wings and the abdomen is completely black, wings of *B. ruderatus* queens are much lighter in color and their abdomen has a yellow base and a white tip. In contrast, males and workers of both taxa are homochromic and show the same color pattern as *ruderatus* queens. However, large workers and small queens of *argillaceus* tend to show color patterns intermediate between *argillaceus* and *ruderatus* queens. It is mainly for this reason that hybrid queens, if they occur, cannot unambiguously be identified, especially since *argillaceus* queens are usually larger than *ruderatus* queens and hence hybrid queens would be expected to be smaller than *argillaceus* queens.

Working in particular on the contact zone in France, we have used enzyme electrophoresis to show that hybridization does occur, however, hybrid queens are very rare. Furthermore, estimates of gene flow suggest that slight gene flow does exist in this area.

#106

HEAD POLYMORPHISM, DISTRIBUTION AND FLOWER PREFERENCE IN EAST ASIAN SUBGENUS STENOMELISSA (HYMENOPTERA, ANDRENIDAE). Osamu Tadauchi (Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

East Asian subgenus Stenomelissa is a distinctive one having the protuberant clypeus, the large process of labrum in both sexes, the highly plumose hairs of tibial scopa in the female, the uncinate apical segments of the antennae in the male. Three species, halictoides (Japan, South Korea), lonicerae (Japan), vitiosa (North China) are included in the subgenus. They show cephalic polymorphism in the males. Larger sized specimens show the mandibles well developed, the head in frontal view quadrangle, the genal area thikened. I studied the various parts of male head size in three species by multivariate analyses and examined intra- and interspecific allomorphosis of the subgenus. I also present the flower preference and distribution in the subgenus.

#107

CLASSIFICATION OF THE SUBGENUS *CALLORHIZA* HIRASHIMA OF THE GENUS *PALAEORHIZA* PERKINS (HYMENOPTERA, COLLETIDAE) OF NEW GUINEA AND AUSTRALIA. Yoshihiro Hirashima and Masaki ABE (Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, 812 Japan).

The bee genus *Palaeorhiza* Perkins, 1908 of New Guinea and Australia contains more than 200 species, and is divided into 16 subgenera. One of them, *Callorhiza* is the largest subgenus, which is composed of at least 40 species.

Callorhiza is still heterogenous, including many diverse and interesting species. So far, 5 species-groups, i. e., the *odyneroides-*, *heterochroa-*, *callima-*, *flavipes-*, and *eumorpha*-groups are known.

In the present study, we recognize 8 more species-groups as follows: the *attractans-*, *fulvago-*, *micheneri-*, *agrias-*, *albopicta-*, *samuelsoni-*, *bagudai-*, and *disrupta*-groups. The characteristics of them will be discussed.

#108

A LIST OF THE KNOWN SPECIES OF APHELINIDAE (HYMENOPTERA:CHALCIDOIDEA) AND THEIR HOSTS FROM CHINA. Huang Jian (Department of Plant Protection, Fujian Agricultural College, Fuzhou, Fujian 350002, China)

The Aphelinidae is an important group of parasitic Hymenoptera. Most aphelinids parasitize the harmful pests such as scale insects, aphids and whiteflies, and are usually the most effective natural enemies of these important pests.

Recently this family includes about 45 genera and more than 1000 species. Based upon the literature and research results by author, a list is given to the known species of Aphelinidae from China in this paper, which records 18 genera and 153 species including 93 species treated in another paper by author entitled "Systematic studies on Aphelinidae of China". They are: Ablerus (1 sp.), Aphelinus (5 spp.), Aphelosoma * (1 sp.), Aphytis (34 spp.), Archenomus (14 spp.), Azotus (6 spp.), Centrodora (1 sp.), Coccobius (15 spp.), Coccophagoides (2 spp.), Coccophagus (21 spp.), Encarsia (28 spp.), Eretmocerus (3 spp.), Eriaphytis * (1 sp.), Marietta (3 spp.), Marlattiella (1 sp.), Proaphelinoides * (1 sp.), Prococcophagus * (7 spp.), Pteroptrix (9 spp.). Those marked with an asterisk (*) are new records for China.

#109

PRIMARY DISCUSSION ON THE INSECT FAUNA IN MT. TIANMU, EAST CHINA. Hong Wu, Ping Yu (Zhejiang Forestry College, Lin'an 311300, China)

In the present paper the insect fauna found in Mt. Tianmu, Zhejiang Province, is analysed, based on 11 orders 1147 species of insects. The types of insect fauna of the world and the Chinese insect geographical region and their percentages of each type are introduced; the similarity of insect found in some localities in or out of China with the mountain are compared; the south and north border of the insect distribution at Mt.Tianmu are also analysed. On these grounds specific faunal features are suggested as below: Mt.Tianmu belongs to the fauna of the Oriental region and near the south border of Palaerctic region; its insect fauna is very rich because of its proper geographical position and special natural condition; its insect community stands in stable equilibrum, which benifits by abundant plant flora, complicated series, plentiful natural enemies and very few interference by mankind; the special terrain, vegetation, geological history of the mountain make many endemic species, survival species and interrupted species.

STUDIES ON THE ACLERIS HÜBNER AND DESCRIPTION OF NEW SPECIES IN CHINA (LEPIDOPTERA:TORTRICIDAE) You-qiao Liu & Jiu-wei Bai (Institute of Zoology, Academia Sinica, Beijing 100080, China).

According to Dr. Razowski(1984),"Microlepidoptera Palaearctica, Sechster Band: Tortricini" 111 species of Acleris are recorded. Among them, 38 species are distributed in China. This paper deals with 45 species of Acleris collected by the authors during the past thirty years.Within them,19 species are already known,11 species are described as new and 15 species are recorded for the first time in China.In addition to the 29 recorded Chinese species have not yet been obtained, a total of Chinese species of this genus amounts up to 74.

Descriptions of the new species and a male genitalia key to 37 species are given in the Chinese text. Two problems are mentioned in the discussions:

1) China possesses a rich fauna of Acleris.
2) Species distribution of Acleris indicates that Northeast and Southwest areas seem the center of origin.

All specimens, including the types of new species are kept in the Institute of Zoology,Academia Sinica.

A STUDY OF THE CHINESE LECITHOCERA HERRICH-SCHAFFER, 1853 AND DESCRIPTIONS OF NEW SPECIES (LEPIDOPTERA: LECITHOCERIDAE) Wu Chunsheng, Liu Youqiao (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Genus Lecithocera Herrich-Schaffer is one of the largest groups in Lecithocerinae. According to Dr. Gozmany(1978), " Microlepidoptera Palaearctica(Band 5: Lecithoceridae)", 47 species of Lecithocera are distributed in palaearctic region; 19 species are recorded in China. This paper deals with 39 species; among them, 22 species are new to science and 5 species are new records to China. In addition to the 11 recorded Chinese species which have not yet been collected by authors, a total of Chinese species of this genus amounts up to 50.

Descriptions of the new species, keys to 50 species respectively by male and female genitalia are given in the Chinese text. Three problems are mentioned in the discussions: <1>. China possesses a rich fauna of Lecithocera; <2>. Each species of Lecithocera in China has a narrow distribution area; <3>. Most of the Chinese species of Lecithocera are distributed in Sichuan Province and the central China respectively.

All specimens, including the types of new species are kept in the Institute of Zoology, Academia Sinica.

SYSTEMATICS ON PEMPHIGIDAE, DREPANOSIPHIDAE AND LACHNIDAE FROM CHINA (HOMOPTERA: APHIDOIDEA) Wan-yu Zhang, Guang-xue Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The present work deals with the fauna of Pemphigidae, Drepanosiphidae and Lachnidae from China during 1987-1991. In the systematic account, 81 genera and 293 species are recorded from China, among them, 1 genus, 51 species are new to science, 26 genera and 63 species are first recorded from China, 13 species are considered as new combinations and 8 species are established as new synonyms. Their taxonomic positions, distributional pattern and relationships with hostplants of these aphids are discussed.

By means of PHYLIP program, the phylogeny of 71 genera of Drepanosiphidae from the world is proposed and its phylogenic tree is also illustrated.

In Drepanosiphidae, setal patterns of embryos in 58 genera are illustrated. The setal patterns do offer some indication of possible direction of evolution. Neoteny is proposed to be a basic mode of evolution in Drepanosiphidae.

PHYLOGENY AND CLADISTIC ANALYSIS OF THE *TUBERCULATUS* MORDVILKO HOMOPTERA: DREPANOSIPHIDAE). Wan-yu Zhang, Guang-xue Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Phylogenetic analysis of 23 Chinese species of the genus *Tuberculatus* Mordvilko, 1894 were carried out. Phylogeny was estimated by MIX Program including Wagner and Camin Sockal parsimony methods for minimizing the number of character reversals and homoplasies using PHYLIP (Phylogeny Inference Package), version 3.2. The cladogram suggested by cladistic analysis show the implication on taxonomy and biogeography. From the results we could conclude as follows: (1)*Sinituberculatus* subg. nov. was established. (2) The analysis suggested that subg.*Orientuberculatus, Acanthocallis and Sinituberculatus* originated from China. (3)The cladogram showed that the traditional taxonomy reflected the evolutionary history in the dorsal hairs on the adult were relatively active characters, while the dorsal tubercules and the characters on forewings were relatively stable ones.

CERCOPIDAE OF THE INDO-WEST-PACIFIC: PRESENT KNOWLEDGE AND PROBLEMS Ai-ping Liang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

A revision of the spittlebug family Cercopidae (Homoptera: Cercopoidea) of the Indo-West-Pacific region was started in 1986. Thirty-six genera and comprising 268 species are revised. Taxonomic novelties include twelve new genera, two new subgenera, 56 new species, eight new subspecies, 42 changes in combination, 8 new generic synonyms, 58 new specific synonyms, and 12 changes of specific status. A study of the principal genus, Leptataspis, is in progress and treatment of the remaining eight genera will follow. From unpublished results it is expected that the number of species will exceed 400 and that some more genera will be described in the near future. A discussion of critical characters useful in the generic and suprageneric classifications is presented and some future research suggestions are outlined.

A STUDY OF THE GENUS DACTYLOTUS SCHOENHERR FROM QINHAI PROVINCE (COLEOPTERA: CURCULIONIDAE). Run-zhi Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The present paper gives the description of 13 new species of the genus Dactylotus Schoenherr (1847) collected from Qing hai province by Wang Shuyong et al in 1964. A key to species, include all new species and 6 known species, D.nitidulus Faust, D. calvus Marshall, D. curvatus Zhang, , D. dorsalis Zhang, D. rugolosus Zhang and D. latiusculus Zhang, is given.

The type specimens are deposited in the Institute of Zoology, Academia Sinica.

A STUDY OF THE GENUS BARYRRHYNCHUS LACORD. FROM CHINA (COLEOPTERA: BRENTHIDAE). Run-zhi Zhang (Institute of Zoology, Academia Sinica, Beijing 100080 China)

In the present paper, 10 new species of the genus Baryrrhynchus from China, are described. A supplementary description of characteristics of the genus Baryrrhynchus is made, and a key to the Chinese species and related species of this genus is given.

The type specimens are deposited in the Institute of Zoology, Academia Sinica.

STUDY ON THE FAUNA OF APOIDEA IN XIZANG, CHINA. Yan-ru Wu (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Xizang located at the west border of China, being famous for its high latitute and plateau.

According to the taxonomic identification, up to the present, the fauna of Apoidea comprises 7 families, 29 genera and 180 species. The ratio of faunistic components is as follows:

faunistic component	spp.	%
Palearctic	77	42.72
Oriental	44	24.44
Endemic	52	28.88
Wide distributed	7	3.88

The Palearctic element occupied the 1st place, endemic-2nd. But the different natural condition of the plateau exert strong influence on the distribution of bees, so different area has its own characteristic, such as Oriental is the main faunistic element in southeastern part of Xizang; south slope of Mt. Hemalaya at the south part of Xizang has a lot oriental species, but above 3000M the Palearctic and endemic species are the main elements. The other areas of Xizang are occupied by Palearctic component.

The boundary line of Oriental and Palearctic Regions in Xizang deliminated at 2300-2800M above sea level at eastern sector (of Mt. Himalaya) and 3000-3500 M at the middle sector of Himalaya.

FORTY YEARS OF ACHIEVEMENTS IN THE ENTOMOLOGICAL EXPEDITION OF CHINA (ABSTRACT) Wang Shuyong Yang Xingke Tan Juanjie (Institute of Zoology, Academia Sinica, Beijing, 100080)

After the founding of the People's Republic of China, the Chinese entomologists have done a lot of work on insect taxonomy and organized a series of scientific expeditions, a large number of insect specimens are increased through the expeditions. Up to the present, there are more than 10 million insect specimens in China: The largest collection in China, with the holding of 3.5 million prepared specimens is in the Institute of Zoology, Academia Sinica,Beijing. In the past forty years, according to six major Chinese entomological and Zoological magazines and the other foreign and domestic magazines, 20 thousand species of insects have been identified and determined, and 8722 species were described as new to science, about 250 new genera and 7 new families (Including subfamilies) have been established, the results greatly facility the publishing of the following works: three volumes of the "Fauna Sinica, Insecta", thirty nine fascicles of the "Economic Insect fauna of China", nine volumes of Insecta atlas, handbooks and Identification books have been published, altogether more than ten thousands species are included. Six monographs on the expeditions are accomplished, among them, "Insects of Xizang (Tibet)", "Insects of Mt. Namjagbarwa region of Xizang". "Living things of Tuomuer peak of Tianshan Mountains" and "Forest insects of Yunnan" have been published, besides, "Insects of Hengduan Mountains Region" and "Insects of Wuling Mountains" are in printing These six monographs include 1403 new species.

TAXONOMIC STUDY OF GENUS PRENOLEPIS MAYR (HYMENOPTERA: FORMICIDAE) OF CHINA. Jian Wu, Changlu Wang (The Research Institute of Forestry, The Chinese Academy of forestry, Beijing 100091, China)

There are total of 8 species and 6 varieties of the genus Prenolepis Mayr 1861 recorded in the world. Up to now, three species are found in China: Prenolepis melanogaster Emery is recorded for the first time from Jinghong and Jingdong Counties, Yunnan Province, China. P. naorojii Forel is distributed over Hunan, Hubei, Jiangxi and Fujian Provinces. P. geei (Wheeler) is collected from Zhejiang, Sichuan, Jiangxi and Guangdong Provinces. The last two species are very common in the south of China.

TWO NEW SPECIES OF GENUS CAMPONOTUS MAYR (HYMENOPTERA: FORMICIDAE) FROM CHINA. Changlu Wang, Jian wu (The Research Institute of Forestry, The Chinese Academy of Forestry, Beijing 100091, China)

Camponotus humerous sp. nov. is described and illustrated from Fenyi County, Jiangxi Province, China. It is close to C. tokioenses Ito, but the body of the new species is shorter, the pronotum is wider, with nearly right humerous angles and margined anteriorly and laterally. C. lasiselene sp. nov. is described from Jinghong County, Yunnan Province, China. It is very similar to C. selene (Emery), differing from the latter in the body covered with abundant erect white hairs.

NOTES OF STENOPSOCIDAE AND ONE NEW GENUS AND SEVEN NEW SPECIES FROM SOUTH CHINA(PSOCOTERA: PSOCOMORPHA). Fa-sheng Li(Beijing Agricultural University) .

This paper deals with one new genus and seven new species from South China. Key is given to the species included, Stenopsocus cubitalis Thornton, 1984 from Indonesia and refered to new genus.

New genus closely related to Stenopsocus but differs from it in having setae on Cu2 and forewing basely.

Stenopsocidae original included six genera, Mockford (1978) translated Matsumuraiella Enderlein, 1906 and Taeniostigma Enderkein, 1901, Smithers (1990) translated Kodanaus Okamoto, 1907 to Amphipsocidae. Genus Epikodamaus was described by Kuwayama(1961) basing upon a male which was collected from Thailand and he erected new genus and new species in forewing M1 forked at apex, Smithers(1972) mentioned: " It is probably a venational aberration".

The author confirmed that Epikodamaus should be synonym of Kodamaus. Till now this family contained Graphopsocus Kolbe, Stenopsocus Hagen and the new genus Malostenopsocus.

A NEW GENUS AND TWO NEW SPECIES OF THE PRICKLYASH-FEEDING PSYLLID FROM CHINA (HOMOPTERA: PSYLLIODEA). Fa-sheng Li (Beijing Agricultural University, Beijing, China)

In this paper one new genus and two new species and their fifth instar nymphs from Xizang Autonomous Region and Guizhou Province of China are described. The feed on Zanthoxylum spp. and psyllids of the feeding-pricklyash are recorded for the first time.

New genus closely related to Epipsylla Kuwayama 1907, but differs from the latter in having antennae about 3 times as long as width of head, male aedeagus without apical paired filament processes and female with suture behind anus.

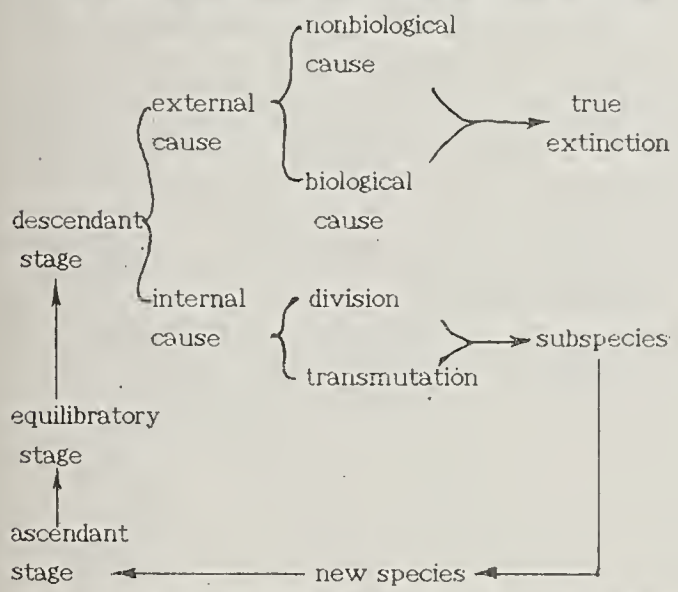
MALLOPHAGE OCCURRING ON THE GENES CROSSOPTILON, GALLIFORMES: PHASIANIDAE). Si-kong Liu (Beijing Natural History Museum, Beijing 100050, China)

This paper reports 11 species of Mallophaga occurring on the genus Crossoptilon, descriptions and a key to the species are provided. Their hosts are:

Mallophaga:	Hosts: Crossoptilon		
	crossoptilon	auritum	mantchuricum
Cuclotogaster h. heterographus	-	-	+
Goniocotes crossoptiloni	+	+	+
Goniodes crossoptilon	-	+	+
Goniodes dolani	+	-	-
Lagopoecus crossoptiloni	+	+	-
Lipeurus keleri	+	+	+
Oxylipeurus crossoptilon	+	-	-
Oxylipeurus baileyi	-	+	-
Amyrsidea (Argimenopon) perdicis	-	+	+
Menacanthus cornutus	-	-	+
Menopon gallinae	-	-	+

A DISCUSS ON THE DEVELOPMENTAL CYCLE OF THE SPECIES. Su-jian Wang (Dept. Biol. Sci. Biotech. Tsinghua University, Beijing 100084, China)

All species are observed the developmental cycle:



If there were not the effect of the external cause, all species would exist to their ideal lifetime and would be transformed into newborn species.

DISCOVERY OF NEW FOSSIL INSECTS FROM HOUCHENG FORMATION OF CHICHENG COUNTY, HEBEI PROVINCE. You-chong Hong (Institute of Natural History, Beijing Natural History Museum: Beijing 100050, China)

A new family--Huaxiarhyphidae fam. nov. (Diptera: Rhyphoidea), collected from the Houcheng Formation (J_{3h}) of Chicheng county, Hebei Province, is described in this paper.

The Huaxiarhyphidae fam. nov. characterized by the special and unique venation. It can be referred to the superfamily--Rhyphoidea and distinguished from other families of it.

Some species of the fossil insects of Houcheng Formation, including Blattoidea and Diptera were discovered firstly in China. These fossils not only fill in the gap of the Houcheng Formation. but also has important significance to the insect evolution in the late Jurassic continuous geological section.

STUDIES ON GENUS SARCOSOLOMONIA BARANOV (DIPTERA:SARCOPHAGIDAE). Zong-mao Ye (Institute of Microbiology and Epidemiology, AMMS, Beijing, China)

Sarcosolomonia, a rather big genus in Sarcophagidae, include twenty one species known to date, among which five species have been found in China. This genus is distributed in the Australian and Oriental regions.

This paper enumerates the diagnostic characters of the genus and describes the female characteristics of S.(P.) nathani Lopes et Kano. Two new species are described that S.(P.) hongheensis sp. nov., was collected from Yunnan, China and S.(s.str.) jipodaoensis sp. nov. from Jipodao, Viet-Nam.

A key is given for the Oriental species, including S.(P.) aureomarginata, S.(P.) crinita, S.(P.) harinasutai, S. (P.) hongheensis, S.(P.) indica, S.(P.) nathani, S.(P.) rohdendofi, S.(P.) shresthai, S.(P.) trifulcata, S.(s.str.) jipodaoensis and S.(s.str.) shinonagai, and their geographical distributions as well.

The paper ends with a discussion on two subgenera, Sarcosolomonia and Parkerimyia, with regard to their diagnostic characters and geographical distributions.

A NEW SPECIES OF THE GENUS POROPOEA FORSTER. FROM BEIJING CHINA (HYMENOPTERA: CHALCIDOIDEA: TRICHOGRAMMATIDAE). Wei-de Luo (Beijing plant Protection Station), Ting-shi Liao (Institute of Zoology, Academia Sinica, Beijing, China)

The present paper deals with a new species of the genus poropoea Forster. Poropoea tomapoderus Luo et Liao sp. nov., which is closely allied to Poropoea morimotoi Hirose(1965), but differs from the latter by the following features: 1. Length of body: female 1.53-1.58mm.(including ovipositor 2.5mm.), male 1.45-1.47mm. 2.Antennae inserted about the middle of the face; club slightly shorter than two funicle segments taken together. 3. Frons with concave only from vertex to toruli and two longitudiual grooves from both side of the toruli to clypeus. 4. Hind wing bearing three rows of cilia on upper side and a row of cilia on under side.

Holotype 1 female; Allotype 1 male; Paratype 1 female. From eggs of Tomapoderus ruficollis Fabricius, Beijing , China, Aug. 3, 1985, collected by Wei-de Luo.

The type sepecimens are deposited in the Institute of Zoology, Academia Sinica.

FLY FAUNA IN CERTAIN HABITATS OF URBAN BEIJING--A FOUR YEAR INVESTIGATION (1987-1990). Hui Zhou (Municipal Station for Epidemic Prevention, Beijing 100013. China), Zong-lin Li, Ri-ming Wang, Lin Wang(Epidemic Prevention Station of Dongcheng Distric, Beijing 100009, China)

Observations in succession from Jun. 1987 to Dec. 1990 were made on the composition and seasonal abundance of Synanthropic flies in some of different habitats of urban Beijing(marketplaces, inns and dwellings). An uniform measure was employed for the investigation. 23 species of 6343 flies belonging to 13 genera (3 families) were trapped, among which Musca domestica took the dominant position making up 78.7%, followed by Lucilia sericata accounting for 12.1%. with a ratio of 3.5:1.0 for indoor and outdoor individuals, both having a similar seasonal abundance emerged in June to July. This result differs from that obtained from another observations made in the same areas with different bait. prompting that several factors including season, habitat and bait, etc. should be in comprehensive consideration for designing a criterion to evaluate the strategies of fly control.

A PRELIMINARY STUDY ON DROSOPHILID SPECIFIC COMPOSITION AND MICRODISTRIBUTION IN MOUNTAINOUS AND HILLY OF ZHEJIANG PROVINCE, CHINA, Jua-zhong Chen (Institute of Genetics, Fudan University, Shanghai 200433, China)

Zhejiang Province situated in the east China at 31°N and 123E, where is homologous the middle subtropics evergreen broadleaf forest zone,which mainly composed of Castanopsis,Cyclobalanopsis, Pasania,Cinnamomum,Schima and Phyllostachys genera. The Study was carried out from May 5 to Nov. 7,1991 at four localities, collection was baited with banana fermented in total 95 traps were placed in different habitat types, a total of over 28,000 individuals were collected, representing 6 genera,47 species of Drosophilidae (including 42 known species and 5 new species) among 74% species belonging to Drosophila genus, in regard to geographical distribution,over 80% speices are assorted to Oriental this is corresponding to the character of floristic elements. As for the number of individuals and species in mountainous and hilly areas, from the results obtained,the former is more abundant than the latter, so the necessity of paying attention to topography was pointed out as to the biofaunistic comparison of Drosophilid assemblages amont different localities. The results indicate that assemblages compositions are obvious, difference among different habitat even within the small areas. An outline of microdistribution of habitat and microhabitat preference of Drosophilid assemblage in Zhiji was pictured. In addition to the domestic species--D.melanogaster was collected in thickly forested mountains and a tropic semi-domestic species D.albomicans was collected in autumn as well as the distribution centre of cosmopolitan,species -- D.immigrans were given some discussions.

A STUDY ON NOTONECTIDAE OF CHINA. Guo-qing Liu, Le-yi Zheng (Department of Biology, Nankai University, Tianjin 300071, China)

In recent years, authors have studied the notonectids cllected from many parts of China. In this paper, 2 species of Notonectidae from China are reported, in which Anisops protracta Liu & Zhang and Enithares tibialis Liu & Zheng were deseribed in recent years. The keys to species are included. Illustrations on diagnostic characters of most species are provided. The geographical distribuion of this family in China is analyzed. Notonecta is distributed extensively all over China, Anisops maninly over the south of Yangtze River. All of the 5 Chinese species of Enithares, except E.sinica, are distributed in Guangdong, Fujian and Hainan provinces. The unique species of Nychia in Chinese fauna is found only in Guangdong province, China.

THE COMPOSITION AND FAUNAL ANALYSIS OF RHOPALIDAE IN CHINA. Liu Qiang (Biology Department, Inner Mongolia Teachers' University, Huhehot 010022, China)

The present paper deals with the composition of Rhopalidae in China and analysis of their fauna. It includes three parts. The first part is an introduction of compositition of Rhopalidae of China, with 32 species of Chinese Rhopalidae noted and some problems revised about faunal divisions of trib and genera and that about their names. An analysis is made in the second part to the rate and belongings of Chinese Rhopalidae in the fauna of the world,thus 6 distribution types are found among which that of Palearctic species is the largest, reaching 56.25%.If the species of both appear faunae are counted in, it amounts to 84.375%. The third part is a comparison between the belongings of Rhopalidae in Chinese entomological fauna, resulting in 16 distribution combinations, among which the largest rate of 18.75% is the species commonly possessed in North-east, Northern China and Mongolia-Xinjiang fauna. Secondly are the endemic species of Mongolia-Xinjiang and S-China fauna,being 15.625%. The rate of other combinations is smaller.

A NEW SPECIES OF THE "MARINE" GENUS THALASSOSMITTIA STRENZKE & REMMERT FROM THE HIGH LAND OF XIZANG (TIBET) CHINA (DIPTERA. CHIRONOMIDAE). Wang Xinhua (Biology Department of Nankai University, Tianjin,300071, China), Ole A. Sæther (Museum of Zoology, University of Bergen, N-5007 Bergen, Norway).

Thalassosmittia montana sp. n. from Xizang (Tibet) is described as male imago. A key to the 6 known species of Thalassosmittia Strenzke & Remmert is presented. T. montana differs from all the other marine species in having no anal lobe, retracted R4+5 of the wing, R2+3 running in the middle between R1 and R4+5, very strong virga and heavily sclerotized,apical teethed phallapodeme.

ZONE DISTRIBUTION AND ESTIMATION OF SCALES OVER INNER MONGOLIA. Li Jie, Li Mingzhao (Baotou Horticulture and Tree Gardening Research Institute, Baotou 014000, China)

There are 7 families, 35 generas, 83 species of scales on herbage over Inner Mongolia, in which 74.7% is Pseudococcidae, 9.5% Eriococcidae, 15.7% Coccidae, Margardidae, Ortheziidae, Aclerdidae, and Diaspididae. These scales distribute over the moderate and the temperate warm grassland zone, and the temperate warm prairie subzone and were widely found on plants of Gramineae, Compositae, Leguminosae and Rosaceae. Although it is not restricted by the composition, density, covering rate of the herbages, the quality of the pasture and the soil saline-alkality, the scale distribution is related to regional climate. Illumination, temperature and soil moisture content have a great effect on the distribution of scales. From 10 recorded families within more than one handred hosts, the grasses can maintain normal growth in most pastroral areas except for Ejin Horo Banner where Artemisia ordosica was severely damaged by Orthezia urticae. Most of scales on herbage parasite at the roots and the crown areas. Since the grass growth didn't differ distinctly in the aboveground parts, the specimen had to be collected from one plant to another. In last few years, 2 genera and 38 species of scales were newly reported in other parts of the world, but 11 generas and 25 species were reported in China, which cover almost 76% of the total scales species.

SALTUSAPHIS SCIRPA THEOBALD WAS FOUND IN CHINA-NEW RECORD TO ASIA. Youlian Li, Sujun Fan, Taiwen Liu, Guoliang Zhang(Department of Plant Protection, Shanxi Agricultural University, Taigu 030801, China)

From 1989 to 1990, we found an aphid which can spring from Carex rigescens (Fr.) Kreez. The aphid is Saltusaphis scirpa Theobald identified by us. It is only reported in France and South of Africa and has never been found in Asia. This paper describes its morphology and behavior in detail. All the aphid specimen were collected from Taigu of Shanxi Province and are deposited in the Entormology Lab of Plant Protection Department of Shanxi Agricultural University.

The major characteristics are as follows:

Apterous female aphid: whole. body gray(in living condition) , antennae brown, body 1.7mm long, slightly brownish spots on dorsum of head, dark spots around the base of setae, frontal tubercle weak-developed. The head is not only narrow but long, no occelar tubercles, segment 1 of antenna expend toward inner, abdominal dorsal setae fanlike. Rostrum short, only extend at the back of foreleg coxa. Femurs of forelegs and middlelegs are both obvious and well-developed. Ventral of tarsus 1 has 5 setae. Siphuncular cone is short and has small thorns on it, and cauda is tumor-like. Caudal plates is divided into two valves. Alate female has brownish side-spots. Setae on each segment has transverse bands and these bands often are mixed. The antenna has 14-20 secondary rhinaria. Veins is well-developed and with halo in two-side of veins. Other characteristics are the same as the apterous female.

The aphid is active and can spring, but its fecundity is weak and has few hosts.

REPORT ON THE FAUNA OF SUBTERRANEAN SCALES IN CHINA REPORT1: THE GENUS ANTONINA (HOMOPTERA: COCCINEA:PSEUDOCOCCIDAE). Jin-juan Hao, Gui-biao Han, Yuan Tang, Fang-teh Tang (Agricultural University of Shanxi, Taigu 030801, China)

The subterranean scale-insect pests were always recorded in China, but we had a little knowledge about the exact fauna of it. Nearly forty years, we paid attention to investigate and collect material for study. The Genus Antonina Signoret 1875 is first reported here.

Up to now, there are 15 species recorded in the world and 3 species in China. 5 species are exactly obtained after country-wide investigation by us. These are Antonina crawii Ckll. A. elongata, n. sp., A. graminis Mask., A. pretiosa Ferris, A. vera Borchs. Antonina vera is reported as new record to China, and the species Antonina elongata as new species to science.

FAUNA STRUCTURE OF PENTATOMIDAE INSECTS IN SHANXI PROVINCE CHINA. Qing-sen Li, Rui Wang, Zhao-qi Bian (Institute of Plant Protection, Shanxi Academy of Agriculture Sciences, Taiyuan 030031, China).

In this paper, based on the analysis of 61 species of insects of the Pentatomidae found in Shanxi, it is found that 57. 38% of the species are confined to the Palaearctic Region, only 16.39% to the Oriental Region. So it suppose that Shanxi may belong to the region of palaearctic in terms of this insect group. Finally the authors list the names of the species collected in Shanxi, and compared with the same species of the neighbour provinces.

A STUDY ON CALYPTERATE FLIES FROM THE PANGQUANGOU NATIONAL NATURE RESERVE IN SHANXI, CHINA (DIPTERA). Mingfu Wang (Hygienic and Anti-Epidemic Station of Yanbei Prefecture, Shanxi Province, China) . Yuxiao Wu (Hygienic and Anti-Epidemic Station of Luliang Prefecture, Shanxi Province China) ,Jianxia Cheng (Hygienic and Anti-Epidemic Station of Shanxi Province, China), Wanqi Xue (Department of Biology Shenyang Normal College, China)

Pangquangou national nature conservation area is located in the middle part of Luliang Mountain range, Shanxi, China, from 111° 22′ to 111° 33′E and from 37° 45′ to 37° 55′ N .

This paper is the result of investigation and sutdy of Calypterate flies. The specimens collected in Pangquangou from 1989 to 1990 belongingto 6 families: Anthomyiidae (14 genera, 28 species) , Fauniidae (2 genera, 7 species), Calliphoridae (13 genera, 19 species), Muscidae (21 genera, 70 species), Oestridae (1 genus, 1 species) , Sarcophagidae (8 genera, 15 Species), and total up to 59 genera, 140 species: including one new species: Portschinskia luliangensis; one new subspecies: Piezura graminicola shanxiensis; besides. Helina bohemani (Ringdahl, 1916) and Mydaea stifemur Ringdahl, 1924 are new records to China.

A NEW SPECIES OF THE GENUS SINOSATYRUS. Tian-wen Cao Ying-ping Xie (Forestry Department, Shanxi Agricultural University, Taigu, Shanxi, 030801, China)

In the genus Sinosatyrus Lee, 1988, there was only one species S. beijingensis Lee, recorded one new species collected from Guandi Mountain, Shanxi, China are reported.

Sinosatyrus guandiensis Cao, sp. nov.

New species resembles S. beijingensis in following characteristics: 1) There are "Y" lines in the middle cells. 2) Imago's fore-legs degenerated. 3) Either side under the base of uneus possesses a thin and long brachium. But the new species differs as following: 1) front area of wings without dark mark along outer margin 2) The "Y" lines in the middle cells and short lines among the veins are not clear. 3) Labialpalpus'dorsal pleura are white. 4) Harpago costa with protruding middle part.

Type specimens: Holotype, 1♀, expanse 56mm, Guandi Mountain, 1700 m, Tian-wen Cao, 13 June 1990. Allotype 1♀, 57mm, same place and collector, 1650m, 19 June 1990. Paratypes, 38♀♀ and 16♂♂, 50-60mm, same place, 1400-1950m, 11 June-10 July in 1984-1990. All specimens are deposited in the forest insect collection of Shanxi Agricultural University.

STUDIES ON TWO ALLIED SPECIEDS OF GENUS LEPIDOSAPHES SHIMER. Guanglu Shi, Yongliang Fan, Lizheng Li, Meijun Zhao (Dept. of Plant Protection, Shanxi Agric. Univ., Taigu 030801, Shanxi Province, China)

This paper reports the studies on two allied species of Lepidosaphes Shimer. In the course of studying the genus from 1985 to 1986, we found that the definition on L. beckii and L. cycadicola was vague. We observed more than 300 specimen and made contrast of each in detail. According to our study, we make sure that there are no sufficient grounds supporting the former classification. L. beckii and L. cycadicola should be one species, the name should be Lepidosaphes beckii. All specimen came from the lab of Species are identified by Professor Fangde Tang. Also , we are in acknowledge of Professor Fangde Tang for his guiding.

NEW ADVANCES IN RESEARCHES OF SYSTEMATICS OF MEMBRACOIDEA FROM CHINA (HOMOPTERA: AUCHENORRHYNCHA). Feng Yuan, Hao-bin Li, Run-Gang Tian (Department of Plant Protection, Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

The advanecs of faunistic and systematic studies on Membracoidea from China from 1851 through 1987 were sumed in 1987. In recent 4 years, Not only investigation, collection, identification and classification on trechoppers from China continued to conduct, but also their cytotaxonomy and nymph taxonomy were carried out. 1 new record of Subfamily (Oryrhachinae), 3 new records of Genera (*Centrotus*, *Oryrhachis* and *Umfilianus*) were discovered, 27 new species to science (*Oryrhachis sinensis*, *Umfilianus yunnanensis*, *Hypsolyrium aleurites*, *H. sapium*, *H. jangxiensis*, *Gargara taibeiensis*, *G. rhopalocera*, *G. ketelceriae*, *Kotogargara parvifrontclyper*, *K. punctata*, *K. cinnamomi*, *Centrotoscelus longus*, *C. querneus*, *C. hunanensis*, *C. brevifrontclypei*, *C. brunneimaculae*, *C. curvilinearis*, *C. pulcher*, *C. brunneimarginatus*, *C. inexcitus*, *C. yunnanesis*, *C. meilingensis*, *C. tenuinervus*, *C. apheliphallus*, *C. arcifrontclypei*, *Ebhul russum*, *E. jinpingensis*) were desecibed, 5 new records of species (*Centrotus cornutus*, *L. bajulans*, *L. longispinus*, *L. lutcinervis*, *Hypsauchenia subfusca*) were reported, 10 new combinations and 8 junior synonym were dealt with. Trechoppers from China are added up to 280 species, 13 tribes, 4 subfamilies and 2 families. The studies of cytotaxonomy indicated that chromosome number of *Hemicentrus*, *Gargara*, *Kotogargaga*, *Ebhul*, *Tricentrus*, *Naondenticentrus* 2n=18+X0; chromosome number of *Leptocentrus*, *Oxyrhachis*, *Pantaleon* 2n=20+X0, chromosome number of *jugkara* 2n=16+X0. The studies on nymph taxonomy showed that 5th instar nymph is significative of classification.

SUMMARIZATION AND BIBLIOGRAPHICAL INDEX OF CHINESE ENTOMOLOGY LITERATURE FROM ANCIENT TIME TO 1990. Huafu Wang (Jiamusi Agriculture College, Jiamusi, Heilongjiang 154002, China)

According to the statistic of the author's book " the Index of Chinese Entomology literature". (caculated from the character of " Cicadas" in ancient book "The book of Songs" to nowadays 1990). There are 10315 pieces of records on insects literature before the foundation of P. R. China, after then, there are 95288 pieces of records on insect literature.

During the time from 1904 to 1990. China all together published 293 sorts of Entomolgy publications (periodical publications 176 sorts, unperiodical publications 117 sorts.). There were 82 sorts before foundation of China, after then, there are 221 sorts. "Silkworm Journal " is the earliest one of them it began to publish in 1904. " Acta Entomologica Sinica" enjoyed the longest time of publishing. It has been published for 33 volumes. 138 issues during the 41 years from 1950 to 1990.

Bibliographical index of entomology in China from ancient time to 1990, total about 3 million words in 7 languages. i.e. Chinese, English, French, Russian, German, Japanese and Italian. Insects are classified to species (about 10,000). The catalogues are arranged according to the sequence of publication date. Every species of insects are noted with its scientific name, its synonyms, Chinese name, its distribution and damages, most of them noted with their English, Russian and Japanese names.

TWO NEW SPECIES OF STENODEMINI (HEMIPTERA: MIRIDAE) FROM CHINA. Zhou-huai Tang (Shaanxi Institute of Zoology, Xian 710032, China)

In this paper, two new species of Stenodemini from China are described. The type specimens are desposited in the Northwestern Agricultural University, Yangling, Shaanxi, China, All the measurements are in millimeters.

Stenodema qinlingensis Tang, n. sp.

Close to *S. nigricallum* Zheng, the differences are: body a little shorter, ♂ 8.29–3.32, ♀ 8.32–8.34; body color of male is darker than in female; hairs of hind tibia exeedingly long, about 1.5–2.5 times the tibia thickness; elasper thickest and with very long hairs in the back; vesica different.

Holotype ♂, allotype ♀, paratype 75♂♂, 102♀♀, Shaanxi (Qinling, 1600–2200m), 1984–Ⅷ–14, Zhou-huai Tang.

Trigonotylus yangi Tang, n. sp.

Allied to *T. coelestialiun* (Kirkaldy), but first antennal segment without reddish longitudinal stripes, 2nd and 3rd antennal segment yellowish. This species can be easily recognized from other speeies of *Trigonotylus* by the different structure of male genitalia.

Holotype ♂, allotype ♀, paratype 4♂♂, 5♀♀, Guangxi (Huaping), 1963–Ⅵ–10, Chi-kun Yang.

SCANNING ELECTRON MICROSCOPY OF THE ANTENNAL SENSILLA OF VIETNAMELLA DABIESHANENSIS (EPHEMEROPTERA: EPHEMERELLIDAE). Cui-rong Su. (Department of Biology, Nanjing Normal University, Nanjing 210024, China)

This paper deals with the fine structures of the antennae of male imago and male subimago of Vietnamella dabieshanensis observed with scanning electronic microscopy. The form of the antennae, the sensillar types, the distribution of various sensilla are described in detail. The sensilla on the antennae include sensilla trichodea, sensilla cheatica, sensilla auricillica, sensilla styloconica and sensilla coeloconica. In subimago the sensilla trichodea can be subdivided into three distinct types according to form and structure. Also there are three morphological types of the sensilla chaetica. All sensilla are localized on the pedicel or flagellar segments of the antennae. But the sensilla styloconica and sensilla coeloconica just occur in the imago. There are a few sensilla auricillica in subimago only. The results suggest that the antennae of both male imago and subimago are valuable taxonomically. It is also revealed that V. dabieshanensis differs from the insects of other orders in form, type and number of antennae sensilla.

CLADISTIC CLASSTFICATION AND GEOGRAPHICAL DISTRIBUTION OF THE CHINESE *STENODEMA* (Hemiptera: Miridae). Zhou-huai Tang (Shaanxi Institute of Zoology, Xian 710032, China)

The present paper is detailed study on the genus *Stenodema* of China. Twenty species of the genus are classified into five species-groups by eight external morphological characters, they are: *S. chinenses* Group, *S. calcaratum* group, *S. virens* group, *S. alpestre* group and *S. longicolle* group. The other five genera of Chinese Stenodemini serves as the combined out-group which will aid in polarizing the characters used in the analysis. The plesiomorphic and apomorphic traits are listed as a result in comparison with the combined out-group. Hennig's method is used for constructing the cladogram. Meanwhile, Farris-Wagner algorithm is also applied. The structures of these two sparate formulated cladograms are completely congruent with each other.

In this article the geographical distribution of the genus *Stenodema* in China is also discussed. The author is of the opinoin that the genus *Stenodema* has its center of specific differentiation in the southwestern mountainous part of China, i. e., from the southwest of the Qinghai-Xizang Plateau to the northwest of Sichuan.

STUDIES ON CALYPEERATE FLIES FROM THE CHANGBAI MOUNTAINS, CHINA. Wanqi Xue, Chuancheng Liang & Hongwei Chen (Department of Biology, Shenyang Normal College, China) KEYWORDS, CHINA CHANGBAI MOUNTAIN ANTHOMYIIDAE FANNIIDAE MUSCIDAE CALLIPHORIDAE SARCOPHOGIDAE CATALOGUE NEW SPECIES.

Changbai mountains is situated in the eastern part of Liaoning, Jilin and Heilongjiang provinces, dense forests, the terrain high and precipitous clear plant zones; the highest peak height is 2690 metres above sea level, snow exists in four seasons at the top of mountain, local name "White top mountain". So far flies distribution of the mountain have not been seen. Through nearly three years investigation, collected the Anthomyiidae, Fanniidae, Muscidae, Calliphoridae and Sarcophogidae, 97 genera, 364species at 40° -44° N. and 123 ° 30′ -129° E., including four new species, one new name, and 33 new records of china (* on the scientific names). The types are kept in the Department of Biology, Shenyang Normal College.

FOUR NEW SPECIES OF THE GENES SOPHROPS FROM CHINA (COLEOPTERA. MELOLONTHIDAE). Zhi-Liang Zhang, ,Yun Gu (Shenyang Agricultural University, Shenyang, Liaoning Province 110161 China).

Sophrops acalcarium sp.nov. Holotype ♂. Guangdong; Guangzhou, 1957; Alltype ♀ Guangdong,Guangzhou.It is similar to S.cantonensis but can be distinguished by punctures in head and rougher puncta in pronotum than sparse in head. Sophrops jiulongensis sp.nov. Holotype ♂, Sichuan,Jiulong,1981.Sophrops huangshanensis sp.nov. Holotypes ♂ Anhuii Huangshan (1983.VII.2). Paratypes 2♂♂, Sichuani Baoxing (1984.VII 30).It is similar to. S.subrugata, but can be distingnished by rather long club in male and a smiooth,slightly elecated longitudinal area in pronotum.Sophrops.yangbiensis sp.nov.Holotype ♂, Yunnang, Yanabi (1980 VII);Paratype ♂.Yunnang, Yangbi It is similar to S.impressicolles, but can be distinguished by the club as loug as the length of znd-7th joints in male, pronotum with a slightly elevated longitudinal area in discus,anterior angle acute.

A NEW SPECIES OF THE GENUS PHAONIA R.-D.FROM NINGXIA HUI AUTONOMOUS REGION,CHINA (DIPTERA,MUSCIDAE). Zhong-yu Ma (Liaoning Health and Anti-epidemic Station, Shenyang 110005,China)Gan Zhao(Medical College of Ningxia,Yinchuan,750004,China)

Phaonia ningxiaensis sp. nov. (figs. 1-2) ♂; Body length about 6.0 mm.Belong to basalis subspeciesgroup and allied to the Phaonia xanthofemina Shino.et kano, 1971, but differs from the latte r by the fore tibia without p seta; eyes sparsely covered with moderate hairs;parafacials black with silvery potinosity;humeral etae 2.Unknown. Holotype ♂, Jingyuan Country (35.5N, 106.3E), Ningxia Hui Autonomous Region,Aug.18.1980, by Gan Zhao. The type specimen deposited in the Liaoning Health and Antiepidemic Station. Phaonia ningxiaensis sp.nov. ♂ 1.terminalia, lateral view, 2.anal cerci,posterior view.

PODONOMINAE-A NEW SUBFAMILY RECORD OF THE CHINESE CHIRONOMIDAE AND THE DESCRIPTIONS OF SYMPTTHASTIA KHORENSIS. Juncai Wang (The Central Station of Environmental Monitoring Liaoning Province, Shenyang 110031, China), Shida Wang (Institute of Hydrobiology, Academia Sinica, Wuhan 430072, China)

This article describes the Boreochlus thienemanni Edwards 1938 of imago male collected from Fengcheng County, Liaoning Province, China. This species is subordinate to Podonominae, and the subfamily are recorded for the first time from China. At the same time, the article describes a Sympolthastia Khorensis Makarchenko collected from huanren County, Liaoning Province in 1984. The species in destribution Russia, but Makarchenko only describes male imago. This article describes additionally the female imago, pupa and larva of the species. The genus and species are recorded for the first time to China.

A PRELIMINARY STUDY ON THE MALE EXTERNAL GENITALIA OF COMMON HOUSE-HOLD COCKROACHES FROM .CHINA. Shouhua Fei (Liaoning Sanitation and Anti-epidemic Station, Shenyang 110005, China)

The present paper describes seven species of male external genitalia of common house-hold cockroaches in China, i. e. Periplaneta americana, P. australasiae, P. fuliginosa, P. japonica, P. brunnea, Blattella germanica and Eupolyphaga sinensis. The taxonomical significance of these genitalia is discussed.

STUDIES OF HOLOTRICHIA CLASSIFICATION. Xue-hui Shang (Anshan Horticulture Institute, Liaoning 114011, China)

Holotrichia classification is the one of the most serious subjects, was suggest in the Symposium of underground insect pests in Xianyang, China. This task has been done since 1976. During 1977-1979, director of the subject enabled Holotrichia diomphalia Bates to mate with H. oblita Falderman. There were 25 pairs in mutual cross experiment, their descendents (F1), 18 males, 32 females. The phenomenon of reproduction isolation was not exist. September 1979, China specialists examined and approved that H. oblita and H. doimphalia was same species. They are two variety species of geography.

TWO NEW SPECIES OF THE TENUIPALPUS OF CHINA (ACARINA, TENUIPALPIDAE). Yong-sheng Cui(Biology Department of Shenyang Normal College, Shenyang 110036, China), Sui-gong Yin (Department of Plant Protection, Shenyang Agriculture University, China).

Tenuipalpus choutinicus Yin et Cui, sp.nov., this species is similar to T.zhizhitashvitiae Reck, 1953, in having the dorsal setae minute and the dorsolateral hysterosomals shorter than distances between bases, but differs in that propodosomal dorsolateral striae mainly transverse and hysterosoma with coalescent areolae mediodorsally.Holotype female, paratype 20females, Oct.6. 1990, Shenyang(Beiting park), on Prunus padus L.. Tenuipatpus mengtunensis Yin et Cui, sp.nov., this species is similar to T.muguanicus Ma et Yuan, 1980, in shape of dorsal setae, and propodosoma and opisthosoma with even reticulations mediolaterally, but differs in that genu I and genu II with 3 setae and longer the 3 rd dorsal setae, and metapodosoma with a few big areolae mediolaterally.Holotype female, allotype male, paratype 2 females, Aug.1.1990, Yunnan (Mengtun), on a kind of arbor. All type specimens are kept in Dep. of Plant Protection, Shenyang Agric.Univ.

STUDIES ON FEMALE GENITALIA OF GENUS CHLAENIUS SPECIES MAIMLY FROM FUJIAN, CHINA (COLEOPTERA: CARABIDAE). Yuan-hong Chen (Institute of Plant Protection, Fujian Academy of Agricultrual Sciences, Fuzhou 350013, China)

This paper gives desriptions of the female genitalia of 13 species of Chlaenius carabid beetle, C. bioculatus Motschulsky, C. junceus Andrewes, C. naeviger Morawtz, C. virgulifer Chaudoir C. micans Fabricius, C. circumdatus Brulle, C. bengalensis Chand, C. ocratus Bates, C. pallipes Gebler, C. costiger Chaudoir, C. nigricans Wiedemann, C. inops Chaudoir and C. prostenus Bates. Important morphological characters are fully illustated. The results of comparation of female genitalia among the species provide with some referent evidences for further identification of species in the Genus.

NOTE ON THE TRUNCATIPENNES GROUP OF THE CARABDS IN SICHUAN AND GUIZHOU PROVINCE (Coleoptera: Carabidae) Tong-ling Huang (Department of plant protection, Southwest Agricultural University, Chongqing Beibei, 630716 CHINA.)

The Truncatipennes are predacious beetles. A key to the species is provided. Among which morphological, biological and distributed notes are given . They are *Brachinus incomptus* Bates , *Drypta japonica* Bates, *D. lineola* Chaudoir , *Colliuris chaudoiri* (Bohem.), *C. metallica* (Fairm.) , *Eucolliuris iltura* (Schmidt-Goebel) , *Macrochilus trimaculatus* Olivier, *Dromius breviceps* Bates, *Callida lepida* Redtenbacher , *Parena latecincta* (Bates).

NEW SPECIES OF RHYSSA GRAVENTHORST (HYMENOPTERA, ICHNEUMENIDAE, EPHLINAE) Rongyu Wang (Dezhou College of Shandong Agricultural University, Dezhou 253015, China)

The genus Rhyssa, Gravenhorst (1829) of very large and stronly elongate species of subfamily Ephlinae. This genus is Holarotic, and two speoies have been introduced into New Zealand and Australia. All species are parasitic on borers in conifers. There are have contains 7 species and 2 subspecies in the world. Towens & Towens (1960) divided the genus into three species groups. 8 new species of the genus Rhyssa Gravenhorst collected from Shandong of China are described. Among these, a species is reported from Dalian, i. e. R. persuasoria L., and 8 species are described as new to science. Their or and hosts are given and a synoptic key to species is provided. All the specimens are deposited in the Dezhou College of Shandong Agricultural University. The new species form described below: (1) R. nebulosia wang sp. nov. host. Anoplophora glacripennis Motschulsky. In the following 7 species are parasitic on sexex sp. in Salix Caprea: (2) R. luteosis Wang sp. nov. (3) R. pseudoneuria Wang sp. nov. (4) R. crista wang sp. nov. (5) R. elatus wang sp. nov. (6) R. gibbus wang sp. nov. (7) R. nigrofacies wang sp. nov. (8) R. nigrofronesis Wang sp. nov.

A PRELIMINARY STUDY ON THE GENUS STENUS (COLEOPTERA: STAPHYLINIDAE, STENINAE) FROM CHINA. I. SUBGENUS PARASTENUS Heydon. Fa-ke Zheng (Department of Biology, Nanchong Teachers College, Nanchong 637002, China) , Xiao-jiang Zheng (Department of Foreign Language, Sichuan Teachers college, Nanchong 637002, China)

Ten species belonging to the subgenus Parastenus of the genus Stenus are recognized from Sichuan Province, China. Among them, 6 species are described as new to science, one species is recorded for the first time from this country. The male genitalia of new species are illustrated. A key to species is included.

ON THE MALE GENITALIA OF THE GENUS *STENHOMALUS* (COLEOPTERA : *CERAMBYCIDAE*) Wei-wen Wu , Shu-nan Chiang (Department of plant Protection, Southwest Agricultural University , Chongqing, Sichuan 630716 , China).

The paper reports the male genitlia of two species of *Stenhomalus* . The structures of the male genitalia formed a kind of new type in *CERAMBYCIDAE* and /or *CHRYSOMELOIDEA*. A name given to this new type as the "cerambycid-chrysomelid type ". The types of male genitalia of *CHRYSOMELOIDEA* should be five instead of four describd by Chen in1987 (cerambycid or megalopodid type , sagrid type, chrysomelid type and eumolpid type) . The cerambycid-chrysomelid type is different from megalopodid in the forked tegmen instead of a annuliform with lateral lobes and from other three types in the median lobe with a pair of median struts . This new finding will have important significance for study of the phylogeny and classification of *CERAMBYCIDAE* or /and *CHRYSOMELOIDEA* .

THE SYSTEMATIC AND EVOLUTION SIGNIFICANCE OF SPERMATHECA IN OBEREA. Cheng Du (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

Dissection of reproductive organs of 23 species and forms in Oberea indicated that spermatheca is of stability inter species and heterogenity between different species, which can be kept in dry specimen without any damage. However, ovipositor, which is very soft and overlapped in virginia is quite difficult to be studied. Spermatheca therefore is a better characteristics in species classification, but also an important base for evolution. The spermatheca of the 23 species and forms in Oberea can be divided into four kinds: 1) irregular, 2) long handle, 3) straight short handle, 4) curvelinar short handle, which were used to establish a evolution tree of four branches according to the theory for spermatheca origin. The shape of the spermatheca of O. incomoleta Fairm at the end of the straight short handle branchof the evolution tree is quite similiar to that of Linda nigroscutata Fairm and Linda actricornis Pic. It is therefore concluded that this branch has evolved to Linda. This evolution tree is quite similiar to that based on the spinules chitinized in the internal sac of male genitalia with only two exception of O. sp, O. formosana, M. ruficirnis Breunning.

FIVE NEW SPECIES OF THE GENUS FORNICIA BRULLE FROM CHINA (HYMENOPTERA:BRACONIDAE). Xuexin Chen, Junhua He and Yun Ma (Zhejiang Agricultural University, Hangzhou, 310029, China).

The genus Fornicia Brulle is one of the few easily recognizable braconid genera and discovered mainly in the tropical and subtropical regions. So far twenty-one species have been recorded in the world, of which six species are known to China. In this paper the Chinese Fornicia is reviewed for the first time and five new species are added: F. prominentis Chen et He, F. imbecillus Chen et He, F. albalata Ma et Chen, F. flavoabdominis He et Chen, and F. minis He et Chen. Each species is fully described in Chinese and illustrated, and its host associations and distribution are given. A key is presented to the Chinese species.

THE OUTLINE OF THE DISTRIBUTION OF AGRICULTURAL AND FOREST INSECTS IN CHINA. Shi-mei Zhang (Jiangxi Agricultural University, Nanchang, Jiangxi 330045, China)

1. The demarcation of the palearctic and oriental regions east to Chinling should be drawn along the south side of Huai River.

2. The demarcation of the palearctic and oriental regions west to Chingling should be drawn along Min Mountain, Qionglai Mountain and Hengduan Mountain, but these three mountains are all oblique from south to north, so the composition of insect species is much more different in vertical position than the level position.

3. The demarcation of the palearctic and oriental regions west to Hengduan Moutain may be drawn at the altitude of 3000～3400 m above sea level at the middle and western seeter of the Himalary, and the altitude of 2800～3000 m as the boundary at the eastern sector of Himalayas.

4. The eopmposition of insect species from south to north at the east part of China varies gradually, and this may be called as the variation of echelon.

5. From the east sea coast to Sichuan Basin, the main insect species are in similarity, but as compared to those to the west to Min Moutain, Qionglai Mountain and Hengduan Mountain, the species differentiate abruptly.

6. The south boundary of palearctic species of insects decline southly from east to west, while the north boundary of oriental species declines north from east to west.

STUDY ON THE BUTTERFLY OF ZHEJIANG. Xuesong Tong, Zuqi Qian (Institute of Lishui Prefecture Agricultural Science, Zhejiang 323000, China)

We began to survey and collect butterflies in Zhejiang in early 1980's. Up to now 322 species of butterflies from Zhejiang have been identified, however, 13 species of butterflies reported in the literature have not been collected. If the latter 13 species are included, 335 species of butterflies, belonging to 169 genera and 11 families, are known from Zhejiang Province.

This paper reports the 335 species of butterflies and their localities of collection. About 60 per cent of the species are of oriental realm, about 30 per cent of the species are of two or more faunal realms and 10 per cent of the species are of palaearctic realm.

With regard to the distribution of butterflies in Zhejiang, relatively few species are found in Hangzhou, Jiaxing, Huzhou plain, and Zhoushan islands, and south-east coastal areas. Most of them distribute in the South-west hilly areas, there are also more species of butterflies distributed in broadleaf forest belt than in conifer and bamboo forest belt in these areas. As regards the vertical distribution of butterflies in hilly areas, more species distributed in half way up the mountain where the trees grow well. With the rise of height, temperature decreases, the species of oriental realm decrease proportionately and the species of palaearctic and of both oriental and palaearctic realms increase gradually.

THE SPECIES OF *PEDIOBIUS* WALKER FROM CHINA WITH DESCRIPTIONS OF SIX NEW SPICIES (HYMEN－OPTERA: EULOPHIDAE) Sheng Jinkun (Department of Plant Protection Jiangxi Agricultural University, Nanchang 330045, China)

In 1987, Liao Dingxi described three new species of *Pediobius*. They are *P. illiberidis*; *P. songshaominus* and *P. yunanensis* . The present paper deals with 16 species, of these, six species are new to science, five species are recorded for the first time from China. They are: *P. planiceps* Sheng et Kamijo, sp. n. (pa: *Melanitis leda* L. pupa); *P. fujianensis* Sheng et Li , sp. n.(pa: *Abraxas* sp. larva); *P. sinensis* Sheng, sp. n.(pa: *Argyrogramma agnata* (Staudinger)); *P.naranga*e Sheng, sp. n.(pa: *Naranga aenescus* Moore, pupa); *P. galerucellae* Sheng et shen, sp. n.(pa: *Galerucella grisesces* Joann); *P. polychrosis* Sheng, sp.n.(pa: *Poychrosis cunninghamiacola* Liu et Pai); *P. facialis* (Girault) (new record) (pa: *Pandemis* sp.); *P. fraternus* (Motschulsky) (new record) (pa: *Hierodula patellifera* Serville, egg); *P. elasmi* (Ashmead) (new record) (pa: *Basiprionota* sp.); *P. inexpectatus* Kerrch (new record) (pa: *Pamara guttata* Bremer et Grey (?) (Hesperiidae)); *P. eublus* (Walker) (new record) (pa: unknown); *P.tamminensis* Ashmead (pa: Euplectrus spp.) *P. mitsukurii* (Ashmead) (pa: *Pamara guttata* Bremer et Grey, pupa); *P. foveolatus* (crawford) (pa: *Epilachna sparsa orientalis* Dieke, larva); *P. pygo* (Walker) (pa: *Amata* sp.; *Apanteles* spp.; *Stathmopoda* sp.(Heliodinidae)); *P. acantha* (walker) (?) *(pa: Phytomyza horticola* Gourea). 7 figs .

ON THE DISTRIBUTION OF COCCINELLIDS IN GUANGXI, CHINA. Tian－sheng Pu, De－wei Wei (Institute of Plant Protection, Guangxi Academy of Agricultural Sciences, Nanning 530007, China)

The Coccinellid fauna of Guangxi is composed of 97 species. The faunal characteristics of Guangxi Coccinellids are explicated on the basis of the distribution. They are follows:

1. The Guangxi Coccinellid fauna of Oriental species is fairly rich (about 26 genera, 63 species, accounting for 64.95% of the total) and 26 concurrent species (26.80%) only distribute in the region of Southern—Middle China.

2. It is found that Guangxi Coccinellids are mainly of narrow spread in one or two regions only.

3. The main areas would be expressed as:

(1)Southern China coastal tropical rain forest sub—region.

(2)Yun—gui western mountain plateau sub—region.

(3)Nanling mountain evergreen rain forest sub—region.

According to annual radiant quanity etc. 5 factors, the subordinate functions of the 3 sub—region can be described by the following equations:

$$\mu_{A_i}(X)=\max r\,(a_i, x) \geqslant 0.99 \cdots\cdots (1)$$

$$\mu_{B_p}(X)=\max r\,(b_p, x) \geqslant 0.99 \cdots\cdots (2)$$

$$\mu_C(X)= r\,(c, x) \geqslant 0.99 \cdots\cdots (3)$$

STUDIES ON SPHINGIDAE OF LUSHAN MT.. Yu-qing Fang.(Lushan Botanical Garden, Lushan Mt., Jiangxi, 332900, China)

This papers deal with the systematic investigation, collection and feeding of Sphingidae in Lushan Mt. and 45 species were obtained. Through the studing of the male adult genitaliae, 40 species and subspecies have been identified. Among them, Oxyambulyx sericeipennis Okano, O. kuangtungen Clark and Gehlenia obliquifascia (Hampson) are new record in Jiangxi. The rest 5 species need further study.

This papers have been divided following 4 sections:

1. The list of Sphingidae in Lushan Mt. and their distributes;
2. The description of 3 new record species in Jiangxi;
3. The adult species index of Sphingidae in Lushan Mt.;
4. The diagrams of the adults of Sphingidae in Lushan Mt. and clavus of the male genitaliae and phalloapexes.

THE BUTTERFIES IN NORTHEAST JIANGXI. Rui-long Zhu (The Forestry Research Institute of Shangrao Prefecture. Jiangxi 334000. China)

This book offers a brief description of the features. hosts and distributions of the 163 species of butterflies from 9 families (namely Hesperlidae, Papilionidae. Pieridae. Satyridae. Danaidae. Amathusiidae. Ridinidae. Nymphalidae and Lycaenidae) found up to the present in the northeast of Jiangxi Province. A check list of the butterflies distributed in this area and colour pictures of 130 butterflies adults are available. Based on a preliminary study of the 16,200 speciemens collected. the book may be used as a reference in teaching, scientific research and actual production.

REPORT ON MOTHFAUNA OF MOUNT HUANG. Cheng-xian Wu, Weng-jie Li (Anhui Province Forestry Institute, HeFei 230031, China)

Mountain Huang is located insubtropical climatic province. Because of the complex topography and the distinct changes of vertical climate, the distribution of the insects is somewhat complicated. Through eight-year investigations, above ten thousand specimens of moths have been collected, of which 471 species belonging to 31 families have been idenfified.

I. Moths of Mountain Huang are composed of two main types-Oriental region and Oriental-Palaearctic common region which account for two third of the sum total, thus belonging to Oriental region without question.

II. Mountain Huang is an alternate area between Oriental and Palaearctic region. Except for the peculiar geographical position, the distribution of vegetation is the primary factor.

III . From the view of vertical distribution, with the rising of theheight above sea level. Oriental region species decrease and Palaearcticregion's increase.

IV. From the view of zoogeographic region, moths of Mountain Huang belong principally to Oriental region, but bear the distinct transitional characteristics of north Oriental region.

SYSTEMS CLASSIFICATION DICTIONARY OF NUMERIC-CODED INSECT NAMES AND ITS COMPUTER IMPLEMENTATION.
Hua-zao Sun,Xiu-ru Zhang,Jia-ming Huang,Hua-main Sun
(Central-south Forestry College,Zhuzhou,Hunan 412006,China).

The Systems Classification Dictionary of Numeric-coded Insect Names is a reference book. Through certain numeric coding models,it puts the multitude of insect species into proper codes. The dictionary has taken in almost all of China's known insect species as well as a large number of significant foreign species, amounting to as many as 31000 entries which belong to 34 order in 502 families of 8603 genera. The dictionary falls into three parts. Part one reads the systems codes, the Latin names, the corresponding Chin se translation and the source of data. Part two is the Latin-code arrangement. And part three appears in Chinese Latin form. So the dictionary provides the prospective reader with the Latin,Chinese and some one third English names of the most commonly found insect species. It also enables him to know the classified standing of his particular species. Moreover,if he arranges his found names according to the code sequence, he easily gets a systems classification list. Besides, the dictionary has been computerized. With the help of the computer and the code package one can readily and precisely retrieve and type out in various forms the Latin and Chinese names and the classified standing of the insect species he wants. Such computer-assisted classification system as this has proved of great help to the arrangement of inventory data and the management of insect specimens.

FAUNAL ANALYSIS OF CARABID BY FUZZY CLUSTERING ANALYSIS.Rui-feng Zheng (Hunan rice research institute, Changsha,410125),Hui-ying Song (Hunan agricultural college,Changsha, 410128).

This paper records 85 species of the carabid beetles(Coleoptera: Carabidae) of 34 counties in Hunan province, China. Among the carabids,there are species of four realms(Oriental,Palaeartic, Austrilian and Nearctic Realm) including 32 species of Oriental Realm, 22 species of Palaeartic Realm.

Carabids in Hunan Pr. consist of 74.11% of species ranging with or beyond Oriental Realm, 60% of species ranging with or beyond Palaeartic Realm. So Hunan is a mixed region of Oriental and Palaeartic.

According to the fauna of Chinense zoogeography, there are more common species in the middle, south, south-west and north of china.

Fuzzy clustering analysis is applied in the fauna of Hunan, according to the features of climate, flora, soil and index of fauna (I·F=N.O/N.P×100 N.O:number of species of Oriental Realm; N.P: number of species of Palaeartic Realm). With the results, Hunan is divided into five regions:the region of Wuling Mountain, Nangling mountain, Xuefeng mountain,Dongting lake and the east-central of Hunan.

ON CADDIS-FLY PREPUPAL AND PUPAL PARASITES OF THE FAMILY AGRIOTYPIDAE FROM CHINA (HYMENOPTERA: ICHNEUMONOIDEA). Hsiu-fu Chao (Biological Control Research Institute, Fujian Agricultural College, Fuzhou, Fujian 350002, China)

Since the publication by Chao (Chao and Zhang, 1981) on the first 2 new species of caddis-fly parasites of the family Agriotypidae from China and a key to the 6 known species of the world, 3 more species had been added to our fauna in subsequent years. They are Agriotypus lui Chao (Chao and Zhao, 1986, Fujian), A. townesi Chiu (Chiu and Wong, 1986, Taiwan) and A. zhengi He and Chen (He and Chen, 1991, Hubei). In the present study, a new genus and 3 new species are described and a key to the 8 Chinese species is given. They are Atopotypus succinctus gen. and sp. nov. (Liaonin), Agriotypus maculiceps sp. nov. (Guizhou) and Agriotypus tangi sp. nov. (Fujian).

Agriotypidae is a small family closely related to Ichneumonidae. They pass the winter in the adult stage within the cocoon in the caddis-fly case and emerge in the spring when the water temperature rises sufficiently to induce activity. The parasitized host case is very characteristic in having a ribbon-like silken appendage which may be about 5 cm. in length attaching to the anterior end of the case. They are known from the Palaearctic (Europe, north-eastern China, Japan) and the Oriental (Hubei, Guizhou, Fujian and Taiwan of China; India, Burma) regions. Careful search for them might reveal that they might also occur in other major zoogeographical regions of the world.

THE TEMPERATURE THRESHOLD OF *DIURAPHIS NOXIA*.. Jun Zhang, Guang-xue Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

In the laboratory, the effects of temperature on the development of RWA were carried out at nine constant temperature condition with a photoperiod of 16L: 8D. No adults developed at 4.5 and 33°C constant temperature condition. Optimal tested temperature region for RWA was 20-24°C. The lower thermal threshold (T_L) and upper thermal threshold (T_u) for development of RWA were estimated (T_L=3.27°C, T_u=26.07°C). This result showes the suitable temperature region for RWA is narrow because of the specific biological habitat of RWA. The effective accumulated temperatures (K) and the instar period (IP) of RWA are 152.55 and 35.29 day-degree respectively.

STUDY ON THE ECOLOGICAL GEOGRAPHIC DISTRIBUTION OF COCCINELLA SEPTEMPUNCTATA IN CHINA. Jun-jie Yan, Zhigang Wang (Hebei Forestry College, Baoding 071000, China), Yuchang Shang, Xiaoming Cai (Dept. of Biology, Beijing Univ., China)

Coccinella septempunctata widely distributed in China, but the abundance of different periods and regions had great difference. The sampling survey was carried out in 29 provinces and autonomous regions from 1978 to 1990 to approach the relationship between the abundance and the ecological environments. Based on the longtude and latitude, elevation, vegetation, phenology, abundance of C. septempunctata and the quantaties of aphids, the comprehensive analysis showed that N29° -42° , E103° -124° central plain of North China, N24° -31° , 86° -109° Yunguei plateau and the south of XiZang (Tibet), N42° -48° , E80° -97° wheat cultivated areas in North XingJiang were three highly densitive occurrent regions and the resource of C. septempunctata in the central plain of North China was great abundant and has the vast utilizing vistas.

AN ANNOTATED CATALOGUE OF SUBORDER CAELIFERA. Yin Xiangchu, Shi Jianping & Yin Zhan (Northwest Plateau Institute of Biology, Academia Sinica, Xining, Qinghai, 810001, China)

According to Kirby, 1910, whose catalogue with 841 genera and 4054 species of Locustidae=Acrididae (including 12 subfamilies: Acrydiinae, Pneumorinae, Eumastacinae, Proscopiinae, Truxalinae, Locustinae, Thrinchinae, Batrachotetriginae, Ommexychinae, Pyrgomorphinae, Pamphaginae, and Cyrtacanthacrinae and The Zoological Record Vol. 1-126 (1864-1990), now there are 2307 genera and 9687 species of the suborder Caelifera (including 8 families: Pneumoridae 9 gen.,19 sp.; Tanaoceridae 2 gen., 3 sp.;Xyronotidae 1 gen., 3 sp.; Trignopterygidae 5 gen., 20 sp.; Acrididae 1822 gen. 7590 sp.; Proscopiidae 31 gen., 164 sp.; Eumastacidae 231 gen., 902 sp. and Tetrigidae 206 gen., 986 sp.; except the Tridactylidae).

The citations and distributions of genera and species are given in this book by the authors.

REVISION OF GENUS GLIPA OF CHINA (COLEOPTERA: MORDELLIDAE). Xiang Fan (Beijing Natural History Museum, Beijing 100050, China)

This paper deals with genus Glipa of China. More than 150 specimens are examined, 17 species are identified, among them 4 new species are described and figured, 1 synonym is discovered. Key to Chinese species as well as species distribution are given.

Glipa crocopuda sp. n.
Elytra black, body length (head+prothorax+elytra) 5.9mm, Elytra: 3.6 mm. Maculation on prothorax and elytra is greyish yellow. Two fore pairs of legs and hind tarsi brownish red. Pygidium long and slender, more than 1/3 the length of elytra, apex narrowly truncate.

Glipa Zhangi sp. n.
This species similar to G. fasciata, but different from latter by stout pygidum, maculation of elytra and shape of paramera.

Glipa angustilineara sp. n.
This species can be easyly distinguished with other by its silvery white narrow maculation and shape of paramera.

Glipa curtopygi sp.n.
Elytra black, body length 7.1mm, elytra: 4. 3mm. Pygidium stout, convergent abruptly at apex 1/3.

Glipa fukiensis Ermisch 1940
G. fukiensis Ermisch 1940 Ent. Blat. 36:167-168
G. shirozui Nakane 1949 Mushi 24:39-41 syn. n.

HENRY WALTER BATES — HIS LIFE AND CONTRIBUTIONS TO BIOLOGY. James E. O'Hara (Biological Resources Division, CLBRR, Agriculture Canada, K.W. Neatby Bldg., Ottawa, Ontario, Canada K1A 0C6) and George E. Ball (Department of Entomology, University of Alberta, Edmonton, Alberta, Canada T6G 2E3).

Henry Walter Bates was born in Leicester, England, on February 8, 1825. Early in life he developed a keen interest in natural history in general, and in insects in particular. He met and befriended Alfred Russell Wallace, and in 1848 the two embarked on a collecting expedition to the Amazon Valley. The two soon parted company, thereafter collecting separately in different areas of Amazonia. Bates returned to England 11 years later, in 1859. He was quick to embrace Darwin and Wallace's theory of evolution by natural selection, and was one of the first to back the theory with evidence from the natural world. A case in point was Bates' (1862) theory of mimicry, that now bears his name. In 1863, his popular book "The Naturalist on the River Amazons" was published. Bates took the post of Assistant Secretary in the Royal Geographical Society of London in 1864 and continued in that position until his death in 1892. During that period he produced in his spare time a prodigious number of publications in systematic entomology. Many were accompanied by insightful discussions of zoogeographic relationships, thus distinguishing Bates as one of the more remarkable and progressive systematists of his time.

A CLASSIFICATION STUDY ON CEROCOCCIDAE FROM CHINA (HOMOPTERA: COCCOIDEA). Ming Xue, Yuliang Shi (Shandong Agricultural University, Taián, Shandong 271018, China)

This paper records 14 species belonging to the two genera Cerococcus Comstock and Asterococcus Borchsenius of Cerococcidae from China, in which one species Asterococcus scleroglutaeus Xue er Shi is new to science and another one Cerococcus indicus (Maskell) is new to China. The new species and new record species are well described and illustrated. A key to adult females of the 14 species is included, and the geographical distribution and host plants of them are introduced briefly also. In addition, some questions on generic morphological characters of the first instars of Asterococcus are briefly discussed. The adult female of new species can be evidently seperated from all other species of Asterococcus by having the sclerotized notum which is just anterion to anal lobe, 50(38-58) 7-locular pores at base of each antonnae.

THE SYSTEMATIC POSITION OF THE NEURORTHIDAE (NEUROPTERA). Ulrike Aspöck (Naturhistorisches Museum Wien, Burggasse 7, A-1014 Wien, Austria)

The Neurorthidae are a small family with about 10 species assigned to three closely related, geographically vicariant genera: Neurorthus (Southern Europe, Northern Africa), Nipponeurorthus (Taiwan, Formosa) and Austroneurorthus (Australia). Up to now the Neurorthidae has been interpreted as the sistergroup of the Osmylidae. Only recently the exceptional position within the Neuroptera has become evident. Morphological characters of the larvae exclude them from the Hemerobiiformia. Thus the Neuroptera constitute three monophyletic groups: Hemerobiiformia, Myrmeleontiformia and Neurorthidae. As a working hypothesis the latter ones are assumed to be sistergroups.

Present knowledge on Neurorthidae is summarized. Hypotheses of the sistergroup relationships within Neuroptera are discussed.

JOIN US: WE ARE FORMING A EUROPEAN SOCIETY OF ENTOMOLOGISTS: M. Buck (Germany), J.C. Franco (Portugal), L. De Bruyn (Belgium) M. De Meyer (Kenya), L. Papp (Hungarian Nat.Hist. Museum), Budapest, H-1088 Hungary), L. Peregovits (Hungary), D. Reavey (U.K.)

We, European entomologists, propose the launch of a European Society of Entomologists. The Society would have two aims: 1) the improvement and dissemination of entomological science among entomologists and among the people of Europe and 2) the promotion and enhancement of international collaboration among European entomologists. The existence of such a Society would strenghten links between the several national societies in Europe without interfering with their interests or undertaking their tasks and duties. We encourage all with an interest in the study of insects to participate (incl. entomologists outside of Europe). We propose that (A) the Society would stand on the widest possible basis to cover all fields of entomology sensu latissimo, i.e. ESE be realized on the widest possible basis; (B) English, French, German and Russian be used for published Society correspondence and news bulletins; (C) the Society publishes one or more international journals in English from its conception; (D) the Society would assist, through the Standing Committee of the ECE, in the organisation of the European Congress of Entomology (every four years).

An informal workshop is planned during the Beijing Congress in order to discuss details for the launching of a ESE.

IMPORTANCE OF MALE GENITALIA IN THE TAXONOMY OF INDIAN ZYGOPINAE (ZYGOPINAE: CURCULIONIDAE: COLEOPTERA). Dalip Kumar (Zoology Department, Govt. College For Girls, Sector-42, Chandigarh, India)

The structure of male genitalia in the studied species shows that it conforms to basic pattern characteristic of the family Curculionidae in general. The male genitalia is comprised of aedeagus and the ring-shaped phallobase. The aedeagus has its dorsal wall poorly sclerotized, and its ventral wall well sclerotized but the degree of sclerotization shows a good deal of variation in different species. The structure of male genitalia varies in different species and endophallic armature provides the reliable character for discrimination of closely related species. The variations relate to the shape of aedeagus, length of aedeagal and phallobasic apodeme and structure of gastral spiculum. The presence or absence of parameral processes of the phallobase also provides useful demarcative features. Out of the six tribes studied, Isorhynchini and Coryssomerini are exceptional in lacking parameres while the remaining four tribes, viz., Lobotrachelini, Mecopini, Othippiini and Sphadasmini show the presence of parameral processes. The male genitalia are thus of great importance in the taxonomy of Indian Zygopinae. Details of the structure of male genitalia in 60 studied species of Indian Zygopinae will be presented.

THE GENUS HYDROPTILA (TRICHOPTERA: HYDROPTILIDAE) IN CHINA. Yang Lianfang (Department of Plant Protection, Nanjing Agricultural University, Nanjing, Jiangsu Province 210014,), Xue Yingen (Department of Plant Protection, Henan Agricultural University, Zheng Chou, Hebei Province,), and John C. Morse (Department of Entomology, Clemson University, Clemson, South Carolina 29634, USA)

A study of the genus Hydroptila in China was conducted on the basis of specimens assembled in 1988-1991 from 47 sites within 12 provinces in eastern and central China. A considerable amount of material was collected by a joint expeditionary team by Nanjing Agricultural University, PRC, and Clemson University, USA, in 1990. Twenty-one species were recognized within six species groups, with two species incertae sedis. Seven species are new to science and two species represent new records for China. Although the temperatures at the 47 sites varied from 9° to 31.5° C, greatest diversity was found between 15° and 22° C. Altitude varied from 30 m to 2250 m. The analysis of historical relationships between Chinese species and species from other parts of the world indicates that there are three tracks as follows: Palearctic China and the western Palearctic Region (2 sister groups), Oriental China and the eastern Palearctic Region north of China (1 sister group), and Oriental China with the non-Chinese Oriental Region (2 sister groups). Ten species are endemic to Oriental China and six species are endemic to Palearctic China.

THE STUDY OF A FAUNA OF LONGICORN BEETLES OF THE FAMILY CERAMBYCIDAE IN XINJIANG. Shui-tian Lu (Forestry Science Institution of Altay Region, 836500, Xinjiang, China)

This paper presents the results of a study of the composition, proportion of 91 insects of the family cerambycidae collected from Xinjiang in fauna. The position, proportion in the geographical division of Chinese animals has also been studied in this research.

The characteristics of the difference and equals compared with others in representative regions (contries) at home and abroad are discussed. The paper has been primarily given the distribution of these insects in middle Asia and Europe-Sibirica fauna in Xinjiang.

COMPOSITION AND FAUNAL ANALYSIS OF PENTATOMIDAE FROM INNER MONGOLIA, CHINA. Nonnaizab, Qi Baoying (Biology Department, Inner Mongolia Teachers'University, Huhehot, 010022, China)

Sixty eight species of bugs in pentatomidae family from Inner Mongolia, belonging to 30 genera in 5 subfamilies were analysed, among which 97.5% belong to the subfamily Pentatominae. Palaearctic species in Inner Mongolian Pentatomidae is 87.7% of the world species. Among Chinese species, 89.7% of the Palaearctic are in Mongolian-Xinjiang, Southern-east and Northern China. The Palaearctic fauna in Inner Mongolia was divided into 3 regions and 6 subregions. 1, Northern-east region: includes Daxinganling Mountains and eastern part next to it on east of Inner Mongolia, and West Liaohe Plain on east of Jerimu League. The Siberia-Mongolian species is main composition in this region. It is further divided into 2 subregions: Daxinganling Mountains and West Liaohe plain. 2, Northern-China region: includes Southern-west part of Jerimu League, Kalaqingqi of Chifeng, south of Yinshan Mountains in Wulanchabu league and eastern part next to Dongsheng of Yikzhao League. Pentatomidae bugs of Loess Plateau mainly appear in this region. 3, Mongolian-Xinjiang region: includes West of Xinganling Mountains, Mongolian Plateau and Erdoss Plateau on north of Yinshan Mountains and Alashan desert. The faunal composition is of panpalaearctic species and middle Asian species. This region is separated into 3 subregions: Inner Mongolia Plateau, Erdoss Plateau and Alashan desert.

MODERN TRENDS IN INSECT SPERMATOLOGY. B. Baccetti (Institute of General Biology, University of Siena and Center for the Study of Germinal Cells, C.N.R., Siena, Italy).

During the early period of electron microscopy it appeared evident that the structure of the sperm cell offers in the class Insecta an impressive degree of complexity and specialization, in comparison with that of any other animal group. Later, it became evident that most of the various discovered models are a consequence of the adaptive radiation to various new reproductive strategies, that strongly influenced the most important sperm functions, like motility and egg penetration. Two lines of research then arose: the evaluation of sperm morphology as phylogenetic character and the peculiarity of insect sperm physiology. At present, the first line has been fruitfully investigated, and nowadays no doubts exist on the validity of the approach. On the contrary, the insect sperm physiology is still quite obscure, and almost nothing is known, e.g., concerning the structure of acrosin or dynein molecules, both detected only by electrophoresis or immunocytochemistry. Important data are now available on the presence and localization of actin and gelsolin. A recently arisen problem is the demonstration of myosin in addition to crystallomitin into the mitochondrial derivates. Another important problem is that of different dynein molecules in different patterns of axonemal structure and motility. The actual data suggest a molecular evolution throughout the class. The motility of aflagellate spermatozoa, the proteolytic activity in absence of acrosome and the glycolysis in absence of mitochondria are other interesting problems, that in various insect orders are solved by parallel and undependent adaptations.

COMPARATIVE SPERMATOLOGY OF BLATTARIA. A.G. Burrini, B. Baccetti, G. Collodel (Inst. of General Biology of the University, and Center for the Study of Germinal Cells, C.N.R., Siena, Italy), I. Huber (Dept. of Biology, Fairleigh Dickinson Univ., Madison, N.J., U.S.A.)

Extremely poor information is available concerning Blattaria spermatozoa, summarized by Baccetti (1987) and Jamieson (1987), in comparison with the large amount of interesting data concerning most of the other insect orders. In this paper we report observations concerning about 30 blattarian species, belonging to the families Cryptocercidae. Blattidae, Blattellidae, Blaberidae (Blaberoid, Panchloroid and Epilamproid complexes). The general features of the blattarian spermatozoon are quite homogeneous: a cylindrical nucleus is capped by a conical acrosome containing a fibrous perforatorium; two almost completely crystallized mitochondrial derivatives flank a "9+9+2" axoneme, a compact centriolar adjunct holds the base of axoneme and mitochondria. Variations occur only in the nuclear and mitochondrial shape, in the organization of the acrosome and in the length of head and tail. The most classical orthopteroid model is that of Cryptocercus, whose acrosomal complex is made up of two juxtaposed cones, while Blaberidae have mostly an anteriorly opened cylindrical acrosome and Blattidae bear a membranous conical cup in front of the acrosome. The length is maximal in Cryptocercus, minimal in Blattidae. Blattidae have in cross section a circular nuclear shape, while this perimeter bears one lateral indentation in Cryptocercus, Blattellidae 2 and Blaberidae from 2 of Blaberus to 4 of Thanatophyllum. In conclusion Blattaria appear a real single order, placed at the base of the Orthopteroid complex and slightly evolved through the various existing families.

NEW FINDINGS IN THE INSECT SPERM AXONEME. R. Dallai (Department of Evolutionary Biology, University of Siena, I-53100 Siena, Italy), B.A. Afzelius (Department of Ultrastructure Research, The Wenner-Gren Institute, Biology E4, Stockholm University, S-106 91 Stockholm, Sweden)

Insect spermàtozoa, starting from Diplura and "Thysanura", have acquired a supplementary set of microtubules external to the basic 9+2 flagellar axoneme. Contrary to the nine doublet and the two central singlet tubules which have a fixed number of protofilaments (pfs) in their wall, the accessory tubules show from 13 to 20 pfs. 16 pfs are common in most orders. 13 pfs are found in Diplura, Ephemeroptera, Psocodea, and the higher Diptera; 17 pfs in Phasmatodea; 19 pfs in most Trichoptera. Variations also occur in the structure of accessory tubule content and the extension of the intertubular dense material. These variations must be carefully considered in the evaluation of the relationship among the groups. Recent studies on insect sperm axoneme have allowed us to specify the exact localization of dynein arms on subtubule A of the doublets; they have also provided a better definition of the centriolar structure and of the origin of the aberrant doublets in the posterior region of some spermatozoa.

THE SPERMATOZOON OF STREPSIPTERA AND ITS PHYLOGENY. Kathirithamby J. (Department of Zoology, South Parks Road, Oxford, OX3 1PS, England), M. Carcupino, M. Mazzini (Department of Plant Protection, University of Tuscia, 01100 Viterbo, Italy)

During his Plenary lecture at the 1988 congress (Vancouver) Baccetti presented a slide of the sperm structure of a Palearctic species, Xenos vesparum Rossi. He later briefly described the sperm tail (Baccettti, 1989). Mazzini, Carcupino & Kathirithamby (1991) gave a first detailed account of the ultrastructure of the spermatozoon of an Oriental species, X. moutoni De Buysson.

After detailed morphological studies, Kinzelbach (1971) and Kathirithamby (1989) concluded that Strepsiptera are a sister group of the Coleoptera. However sperm ultrastructure led Baccetti (1989) and Mazzini et al. (1991) to conclude that Strepsiptera were unrelated to Coleoptera.

Study of a further range of species suggests that Strepsiptera may have developed as Coleoptera from some relatively generalized Pterygote.

THE EVOLUTION OF COLEOPTERAN SPERMATOZOA. A.R. Magnano, B. Baccetti, A.G. Burrini, P. Piomboni and T. Renieri (Inst. of General Biology of the University and Center for the Study of Germinal Cells, C.N.R., Siena, Italy).

The coleopteran spermatozoon as described in literature (Jamieson, 1987) is basically of the classic pterygote type, having a bilayered acrosomal complex, a cylindrical dense nucleus, 2 almost fully crystallized mitochondrial derivatives, a "9+9+2" axoneme. In spite of the large number of described species, and the high differentiation attained by the several families of the order, the early descriptions of the coleopteran spermatozoon revealed a fairly constant model. Recently, more accurate studies have demonstrated in Ptiliidae (Baccetti and De Coninck, 1989), Curculionidae (Burrini et al., 1988) and Chrysomelidae (Baccetti and Daccordi, 1988) several peculiar features, as aflagellarity, or unusual patterns in axonemes or accessory bodies suggesting a high level of evolution also in the sperm structure. In this paper we give a general review of the group.
Taking together all available data, it seems that Coleopteran sperm model starts at a high level of Pterygote sperm evolution. In fact at least two crystalline juxta-axonemal accessory bodies are present also in Carabidae, and seem to represent a constant feature of Coleoptera. Moreover, the centriolar adjunct is absent in the mature sperm of all the species of the order. The acrosome plus perforatorium complex is maintained in all families, as the "9+9+2" axoneme does, except in the peculiar aflagellate Ptiliidae model, where both axoneme and perforatorium are lost. Therefore bi-layered acrosome models are maintained till the highest families, where also the three-layered model appears. The most peculiar evolution in the order is demonstrated by the accessory bodies, that are two in the primitive families, and reach the number of 5 in Donacinae. In conclusion a phylogenetic tree traced on the basis of the sperm structure seems to be in good agreement with the actual general views on coleopteran phylogeny and evolution.

COMPARATIVE SPERMATOLOGY AS A PHYLOGENETIC INDEX IN PROTURA. Wen-ying Yin, Lu-zhen Xue (shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China).

The Proturan spermatozoa can be grouped under two main types: the flagellated elongated spermatozoa and the aflagellated shortened ones, which are representing two evolutionary lines: the one is showing that the structures of the acrosome trends to complicated, and the number of the peripheral doublets of the axoneme gradually increased. The other is towards simplification, the spermatozoa lost of acrosome and flagellum in the beginning and until that only the nucleus remains in a sperm cell.

In early works, the aflagellated sperm were found mainly in the group which possess tracheal system. So it was considered that the aflagellated sperm is an apomorphy of Eosentomids. Recently we found the aflagellates also in the groups without tracheal system, such as Fujientomon, Huhentomon and Acerella. That indicating the aflagellation of spermatozoon is not inevitably take place parallel with the tracheal system.

Through the comparasion, that the spermatozoon of Hesperentomon may be the primitive type, while the spermatozoon of Eosentomids probably represent the most evolved type. A spermatozoal evolutionary tree, according to the apomorphies of the spermatozoa of Protura was drawn.

Comparative spermatology apears to be a very useful tool to clarify phylogenetic problems in Protura.

GERM CELL CLUSTER FORMATION IN INSECT OVARIES. J. Büning (Institute of Zoology I, University Erlangen, D-8520 Erlangen, F.R.G.)

Insect ovaries are organized in ovarioles. Each ovariole is composed of somatic and germ cell tissues. 3 different ovariole types: panoistic, polytrophic- and telotrophic-meroistic exist, which are analysed in all insect orders by comparing their ontogenesis. Panoistic ovarioles can be developed: 1) by blocking germ cell cluster divisions totally, as is found in most "primitive" insects; 2) after germ cell cluster formation by final cleavage of cystocytes, which all develop as oocytes as found in stone flies or thrips. Polytrophic meroistic ovaries of similar character are found in paraneopterans and holometabolans, indicating common origin. Key invention is the differentiation of only one oocyte, which generates from one central cell of the cluster, whereas all others will be transformed into nurse cells. Telotrophic ovaries differ from polytrophic ovaries, by retention of all nurse cells in an anterior trophic chamber and by changing oocyte - nurse cell determination. This type developed three times independently out of polytrophic ancestors and one time directly from panoistic insects in mayflies.

ORGANIZATION AND ACTIVITY OF NURSE CHAMBER AND OOCYTE NUCLEI IN GALL MIDGES. M.Gruzova (Institute of Cytology Ac.Sci.USSR, St.Petersburg, USSR)

In polytrophic ovarioles of zoophagous Aphidoletes aphidimyza (Cecidomyiidae) each follicle consists of syncitial multinuclear nurse chamber(NC) and oocyte. The number of nurse nuclei(NN) in NC(s) varies from 5 to 14. Only one complex nucleolus developes in every polyploid (up to 2000 C) NN, which incorporates ^{3}H-uridin more actively during previtollegenesis. RNA is transported from NN to trophoplasm in the form of perinuclear bodies which incorporate ^{3}H-uridine and ^{3}H-thymidine. Oocyte nuclei (ON)lack nucleoli. The center of ON is occupaied by 4 or 5 compact S-bivalents, surrounded by a network of strands. Diffuse E-chromosomes(ch) are located on periphery of ON. There are 1-3 small nuclei(SN) in ooplasm. E-ch are transcriptionally active during whole oogenesis while S-ch - only at the end of oogenesis. Still share of ON in oocyte RNA pool is insignificant in comparison that of NN (≈1:100). The Ag-NOR's reaction reveales intensive impregnation of E-ch, chromatin of SN and nucleoli of NN.Similar morphology of ON and NN and their activity were demonstated in ovarioles of phytophagous gall midge. (Kunz et al.,1970). The nature and functions of E-ch and SN in oogenesis of gall midges are discussed.

THE STRUCTURE OF OVARIES AND OOGENESIS IN ENTOGNATHAN INSECTS. S.M. Biliński (Institute of Zoology, Jagiellonian University, 30-060 Kraków, Poland)

Two well-defined categories of female gonads can be discerned among entognathans. In Protura, Collembola and Diplura: Campodeidae the paired ovaries are sac-shaped and not divided into discrete ovarioles. In contrast ovaries of Diplura: Japygidae are composed of 7 segmentally (metamerically) arranged ovarioles. Ovaries (ovarioles) of proturans and japygids are panoistic, whereas those of collembolans and campodeids are polytrophic-meroistic. In all collembolans and campodeids studied so far germ cell clusters are nonbranched, chain-like. Oocyte differentiates from the cell placed more or less centrally within the chain. Other cells become the presumptive nurse cells. The structure and function of the oocyte nucleus are entirely different in the panoistic (Protura and Japygidae) and meroistic (Collembola and Campodeidae) ovaries. In the latter ones, the oocyte nuclei are generally small and not active in RNA synthesis. In proturans and japygids the oocyte nuclei are large and contain huge, active nucleoli. The possible evolution of entognathan ovaries is also discussed.

POST-ENDOCYTIC PROCESSING OF YOLK POLYPEPTIDES IN OVARIAN FOLLICLES OF THE STICK INSECT CARAUSIUS MOROSUS Br. F. Giorgi (Department of Biomedicine, University of Pisa, Italy).

Ovarian development in stick insects entails vitellogenin (Vg) uptake into early endosome-like vesicles or yolk spheres. Upon completion of vitellogenesis, yolk spheres undergo progressive fusion to form a late yolk compartment. This study examined how Vg polypeptides are processed during uptake into the oocyte and subsequent transfer into the late yolk compartment. Accordingly a panel of monoclonal antibodies (Mabs) was developped and used for western blotting. By this technique, several Vg polypeptides were shown to bear a precursor-product relationship. In addition vivo labelling proved that Vg polypeptides are extensively processed during ovarian development. Various enzyme activities responsible for such a processing were detected in ovarian follicles at all stages and their localization and substrate specificities determined. Developmentally different follicles were also studied ultrastructurally and cytochemically to determine how newly endocytosed vitellogenin comes to interact with lysosome-like organelles to undergo processing. It is suggested that Vg polypeptides are modified in charge and molecular weight to allow native vitellins to form larger aggregates by the end of oogenesis.

CHROMATIN ORGANIZATION AND REGULATION OF rDNA TRANSCRIPTION IN ACHETA (ORTHOPTERA) OOCYTES. Michael F. Trendelenburg, Herbert Spring (German Cancer Research Center, D-6900 Heidelberg, Fed. Rep. Germany) Helmut Tröster (Univ. Mainz, D-6500 Mainz, F.R.G.), Jan-Erik Edström (Univ. Lund, S-22362 Lund, Sweden)

Ovarioles of the house cricket Acheta domesticus show a typical panoistic type of organization, as characterized by a particularly high transcriptional activity of oocyte nuclear chromatin.

Oocyte chromosomes display a lampbrush-like organization, however, individual lateral loop structures are very small and can only be appropriately visualized, when video-enhanced light microscopy and/or confocal laser scanning microscopy is used for chromatin visualization.

One of the most interesting cytogenetic observations on rDNA chromatin organization is the fact, that rRNA is transcribed, (i) from extrachromosomal amplified micro-nucleoli, located as a characteristic sphere at one side of the oocyte nucleus and, (ii) from chromosomal rDNA cistrons, the nucleolar organizer regions (NORs).

A third rDNA-associated structure, the 'Binnenkörper' was always observed to be located in very close association to the extrachromosomal nucleoli. In the past, it had often been argued, that this structure also may contain rDNA chromatin. However, a thorough analysis using DNA-specific dyes and UV-confocal laser scanning microscopy clearly resulted in the finding, that this conspicuous nuclear organelle is devoid of DNA.

The clear structural definition of these three major components of the rDNA transcription apparatus will allow to follow the structural changes of these components during the major stages of oogenesis.

ELECTRICALLY MEDIATED MOLECULAR MOVEMENT IN INSECT FOLLICLES. Richard I. Woodruff (Dept. of Biology, West Chester Univ., West Chester, PA 19383, U.S.A.

In living cells, electrical currents can influence the distribution of charged macromolecules. In the developing ovarian follicles of insects, measurements with intracellular electrodes have revealed an electrical polarity across the intercellular bridges which link nurse cells to the oocyte of each follicle. Microinjection of fluorescently labeled charged proteins has been used to study the effect of this polarity. Voltage gradients are focused at the nurse cell-oocyte intercellular bridges: thus exchange between the two cells is gated by the electrical gradient. In Hyalophora cecropia, ion selective microelectrode measurements and luninescence of microinjected aequron reveal that $[Ca^{2+}]_i$ is not in electrochemical equilibrium, and may be responsible for the trans-bridge potential gradient.

Recent findings now suggest that this polarity is involved in mediating developmental events in the oocyte. In H. cecropia, the electrical polarity has been linked to activation of follicular growth and to differential regulation of the oocyte vs. nurse cell nuclei. In the absence of the normal electrical gradient, the dormant oocyte germinal vesicle regains synthetic activity.

NURSE CELL - OOCYTE INTERACTION IN THE TELOTROPHIC OVARY. Erwin Huebner and William Diehl-Jones (Department of Zoology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Ultrastructural, immunocytochemical, and electrophysiological analysis of insect telotrophic ovarioles reveals a high level of structural and functional polarity. The cytoskeletal and electrical polarity have both been implicated in playing roles in nurse cell -oocyte transport. This paper will focus on these aspects, in particular using Rhodnius prolixus and other hemipterans as model systems. Immunocytochemical and biochemical study has shown involvement of microtubules and molecular motors. Microinjection of charged proteins (FLY and McFLY) and charged latex beads indicate charge plays a role. Neutral and negatively-charged beads are transported from the tropharium into the oocytes. Two-dimensional vibrating probe analysis coupled with techniques identifying which ions carry the currents make the experimental analysis of their role in transport possible. Results with Rhodnius demonstrate calcium and sodium are key ions. Research supported by NSERC grants to E.H.

YOLK PROTEIN ACCUMULATION IN LOCUST OOCYTES. Hans-Jörg Ferenz (Insect Physiology Group, University of Oldenburg, D-2900 Oldenburg, Federal Republic of Germany)

In most insect species yolk protein(s) are extraovarially synthesized by the fatbody and then transported to the maturing oocytes and sequestered by them. The uptake process has all characteristics of a phenomenon called receptor-mediated endocytosis in which a membrane-bound receptor protein specifically binds vitellogenin as its ligand. The receptor-ligand complexes are incorporated as coated vesicles and processed resulting in the release and aggregation of the yolk protein and a possible recycling of the receptor molecule. The vitellogenin receptor of *Locusta migratoria* has been isolated, purified and biochemically characterized as an acidic 180 kDa membrane glycoprotein specifically binding locust vitellogenin with an equilibrium constant of $K_d = 10^{-7}$ M. In transmission electron microscopic studies the endocytotic pathway for vitellogenin was documented. With a polyclonal antibody directed against the locust vitellogenin receptor in combination with protein A-collodial gold the receptor could be localized in oocyte membranes, coated pits and coated vesicles but not in yolk spheres. Comparative studies with immunoblotting and ligand blotting techniques including other insect and non-insect species indicate the conservation of structural and functional elements important for internalization of vitellogenin.

REGULATION OF VITELLOGENESIS IN *DROSOPHILA*. Mary Bownes, Alberto Martinez, Elaine Ronaldson & Debbie Mauchline (Institute of Cell & Molecular Biology, University of Edinburgh, Darwin Building, Mayfield Road, Edinburgh EH9 3JR).

During vitellogenesis in *Drosophila* three yolk protein genes, *yp1,2* and *3*, are expressed in the female fat body and in the ovarian follicle cells. The proteins they encode are transported to the ovary and selectively endocytosed into the oocyte. These processes are regulated by a number of factors including the sex-determination hierarchy , tissue specific proteins, the hormones Juvenile Hormone and ecdysone, and the nutritional status of the fly.

We will describe new results on the regulation of expression of these genes in each tissue including results with the previously unstudied *yp3* gene and with Juvenile Hormone. We will also discuss studies concerning the selective uptake and storage of the yolk protein in the oocyte.

THE FOLLICULAR EPITHELIUM OF INSECT OVARIAN FOLLICLES: STRUCTURAL AND FUNCTIONAL ASPECTS. H. O. Gutzeit (Institut für Biologie I (Zoologie) der Universität Freiburg, Albertstr. 21a, D-7800 Freiburg, Germany)

The follicle cells of insect ovarian follicles serve several important functions during oogenesis. These functions require the regional differentiation of the follicle cells which may proceed autonomously even when the germ-line cells do not execute the normal developmental program. In several polytrophic insect species the follicle cells and the attached basement membrane possess mechanical properties which are important for the generation and maintenance of the follicular shape. Components of the cytoskeleton in the follicle cells are organized circumferentially in many insects (microtubules or microfilaments). In previtellogenic and early vitellogenic *Drosophila* follicles a component of the basement membrane (laminin) is also organized in this way. The inferred limitation of the nurse cell volume may have implications for the intrafollicular transport of macromolecules and organelles from the nurse cells to the oocyte. Other functions of the follicle cells in the germarium and, later, during vitellogenesis will be summarized.

ULTRASOUND SENSITIVE EARS IN A TACHINID FLY. Klaus-Gerhard Heller, (Dept. of Zoology II, University of Erlangen - Nürnberg, D-W-8520 Erlangen, Germany), R. Lakes - Harlan (University Göttingen, Dept. of Zoology, Berlinerstr. 28, D-W-3400 Göttingen, Germany)

Hearing organs are known from many different insect orders where they are used mostly in acoustic communication or predator defense. Except for some near field receptors (particle displacement detectors) sensitive to low frequency sound they are always built as tympanic organs with large membrans reacting to sound pressure changes. Tympanal organs, however, have never been detected or described within flies (order Diptera), although several studies have documented the attraction of fly parasitoids to the songs of their hosts.

We observed the parasitoid fly *Therobia leonidei* (Tachinidae, Ormiini) infecting only sound producing bushcricket males. Both sexes of the fly possess an enormously inflated prosternum formed by tracheal airs sacs. Its anterior wall, a 1μm thick membrane, is very sensitive to ultrasound according to measurements using a laser vibrometer. A large sensory organ with about 400 scolopidial cells is attached to this membrane. Its sensitivity to ultrasound could be documented by electrophysiological recordings.

Unlike all other insect tympanic organs this fly ear is larger in females than in males, probably due to its main function, with is obviously not in communication or predator defense, but in prey detection, also not found in other insect hearing organs.

ORIGINS OF THE CYCLOPEAN MANTIS EAR. David D. Yager (Department of Psychology, University of Maryland, College Park, MD 20742 USA).

Many praying mantises have a well developed auditory sense mediated by a single, midline ear. The ear comprises two tympana facing each other within a deep groove. In most species, the ear is specialized to hear only ultrasound and functions to protect the mantis from capture by hunting bats.

Auditory capability appears gradually in praying mantis nymphs and parallels changes with age in the gross structure of the ear. The neural elements of the peripheral auditory system are in place at hatching. In 1st instar nymphs, the tympanum is represented only by a small vertical slit and the walls of the groove face posteriorly rather than medially. The adult orientation arises by progressive rotation of the walls along two axes and broadening of the slit into a membrane. Increasing auditory sensitivity is linked to structural changes in the periphery, in particular, the progressive development of impedance-matching tympanal tracheal sacs.

A museum survey of 330 of the 400 mantis genera reveals four major types of auditory structure and function that suggest phylogenetic patterns in the origin of the ear. Most mantises examined had the morphology indicative of good ultrasonic hearing. More than a third of the species show strong auditory sexual dimorphism – males have a functional ear, but females do not. Mantises of one subfamily have not one, but two ears. The ears are serial homologs that hear entirely different frequencies. Finally, some New World mantises are deaf and have 'ears' almost identical to those of newly hatched nymphs and to a deaf outgroup, the cockroaches. Based on these results, it is possible to suggest an 'auditory phylogeny' for the suborder Mantodea.

ALLOMETRIC EFFECTS AND THE EVOLUTION OF SOUND PRODUCING ORGANS IN CRICKETS. R.B. Toms (General Entomology, Transvaal Museum, Box 413, Pretoria, 0001 South Africa)

Cricket calling songs are used by females to locate conspecific males, and changes in these songs are crucial to speciation. Since certain features of cricket sounds are correlated with the structures of the stridulatory organs, changes in stridulatory organs must be correlated with changes in songs. Surprisingly, there is no established hypothesis to explain the mechanism of morphological change associated with changes in songs. Some alternative possibilities are explored, with special reference to allometric effects. Available evidence suggests that stridulatory organs are genetically stable, and that changes in these organs occur in steps rather than gradually.

THE TETTIGONIID EAR - MULTIPLE FUNCTIONS AND STRUCTURAL DIVERSITY. Winston J. Bailey (Department of Zoology, University of Western Australia, Western Australia 6009).

The tettigoniid ear is formed by a pair of cuticular tympana situated beneath the knee of the foreleg. Movements of the tympana are detected by a group of receptors, the *crista acustica,* which respond to high frequency airborne sound. The tympana are backed by a specialised trachea which continues as a sound tube along the leg, opening to the outside via a hole in the thorax near the prothoracic spiracle. The cuticular structures surrounding the ear and the shape of this auditory trachea influence the sound frequencies over which the ear responds. These frequency-filtering structures show remarkable structural diversity throughout the taxon, for the ear not only functions to receive calls of conspecifics, but also those of heterospecifics and noises made by predators. The sound guides and tracheal tubes both enhance the ear's sensitivity to conspecific frequencies and also exclude, by their tuning characteristics, sounds that may mask relevant frequencies. This paper considers those selective pressures that may have influenced structural diversity. Included is a discussion of a hearing system which is almost atrophied in one monotypic subfamily, the Phasmodinae, and in another, the Zaprochilinae, shows a highly reduced condition in one sex. This constitutes a rare case of sexual dimorphism associated with hearing in the Tettigoniidae.

SOUND PRODUCING ORGANS OF NEW ZEALAND STENOPELMATIDAE (ORTHOPTERA). L.H. Field (Department of Zoology, University of Canterbury, Christchurch, New Zealand)

Four basic types of stridulatory mechanisms were found in the 34 species (7 genera) of wetas examined. The mechanisms include: (1) tergo-femoral, (2) tergo-tergal, (3) mandibulo-mandibular and (4) pleuro-coxal. These fell into twelve groups, based upon shape, density and pattern of tergal and femoral pegs, number of terga bearing pegs, and presence of mandibular tusks bearing tubercles.

In three related groups (4 spp, 3 spp and 10 spp), the density of tergal and femoral pegs, and the number of tergites bearing pegs, increases. The spinose tergal pegs form patches on the anterior three to six tergites. These three groups comprise the large genus *Hemiandrus* and two monotypic genera (n. gen. A & B, one of which is the large tusked weta). In the next group, the tergal pegs are patches of raised slats, restricted to tergites I and II (*Deinacrid*a: 3 spp). The following four groups show a modification of the raised slats into lowered ridges, which are first arranged into a few overlapping rows to form a crude file (*Hemiandrus monstrosus*), then into a single narrow row of many ridges to form a clear file (n. gen. C), and finally into two groups with marked reductions in the number of file ridges (*Hemideina*: 2 spp and 3 spp, resp.). In these and subsequent groups the file is restricted to tergite II. In two final groups the file is reduced to one or two thick massive ridges and the femoral pegs are enhanced by becoming raised molariform structures (*Deinacrid*a: 2 spp and 3 spp, resp.). In one of these species the tergo-tergal mechanism occurs.

The stridulatory structures can be deployed in five different kinds of movement associated with defense, disturbance, agonist and courtship behaviour.

ULTRASUBHARMONIC RESONANCE AND NONLINEAR DYNAMICS IN THE SONG OF OECANTHUS NIGRICORNIS. Enrico Sismondo (22 Leedon Road, Singapore 1026, Republic of Singapore)

In O.nigricornis the carrier frequency of the song normally equals the tooth-strike rate; rarely the two are not equal, but phase-locked in ultrasubharmonic ratios such as 4:3 or 5:4. Sometimes both frequencies are simultaneously present, giving rise to acoustic beats with two sharp frequency peaks related by similar ratios.

I have artificially induced the above phenomena in normal live singing crickets by experimental modification of one or both tegmina: beats arise when one of the two tegmina vibrates at the tooth-strike frequency while the other vibrates at the ultrasubharmonic frequency.

I present a mathematical model of the Oecanthus tegminal resonator, consisting of two simple coupled differential equations, one of them with a nonlinear restoring term. Integration of the model at various values of tooth-strike rate and exciting force yields all of the observed phenomena, including normal and ultrasubharmonic output frequencies as well as beats between the two. The resulting waveforms and acoustic spectra accurately reproduce those found in natural and experimental recordings.

CYTOSKELETAL ASSOCIATIONS WITH INTERCELLULAR SEPTATE JUNCTIONS IN THE MIDGUT OF COLLEMBOLA by Romano Dallai, Department of Evolutionary Biology, University of Siena, I-53100 Siena, Italy.

Collembola and Protura are considered related groups. The comparative analysis of the morphological characteristics of smooth septate junctions in their midgut indicate that the junction is similar in many aspects in the two orders and differs from that of pterygotes. The continuous junction of the collembolan Isotomurus, however, shows an atypical organization due to the unusual presence of an apical fibrous belt-like structure, similar to a terminal web, anchored to the lateral plasma membrane at the junctional level. This fibrous structure, where the bundles of microvillar microfilaments terminate, is not affected by cytochalasin and Triton treatments; immunoelectronmicroscopy with antibody anti-actin coupled with colloidal gold particles did not reveal actin at the web level while it specifically labelled the microvillar content. Moreover the microvillar microfilaments, but not the filamentous material of the web, are decorated by S_1 subunit of rabbit heavy meromyosin. All this suggests that the web is possibly made up of intermediate filament related proteins.

ADHAERING AND OCCLUDING JUNCTIONS IN INSECT TISSUES by Nancy J. Lane, Department of Zoology, Downing Street, Cambridge, CB2 3EJ, England.
The cells in insect tissues are held together by a range of junctional types. With the exception of gap junctions, many of these intercellular contacts are intimately associated with cytoskeletal components, in particular actin filaments. In some cases these appear to be anchored in turn onto underlying microtubules (MTs); this is especially apparent in focal contacts where hemi-adhering associations are made to the extracellular cuticle that overlies the epithelia in the fore- and hind-gut of insects. Treatment with actin destabilizers such as cytochalasin B, leads to the separation of actin from the MTs. A similar spatial association of actin with MTs can be observed in septate junctions, in the mid-gut, where cytochalasin leads to disruption of the septate junctional intramembranous patterns. Intermediate filaments in association with desmosome-like contacts are not to be found in insect material, instead, actin filaments apparently insert into both the observed zonular and macular adhesive junctions, identified by LM labelling with phalloidin conjugated with fluorescent probes or by EM labelling with the S1 subunit of rabbit heavy meromyosin. The tight junctional-associated actin can likewise be labelled; a new model for the zonula occludens, based on rapidly-frozen tissues, will be presented. These junctions appear to act as the basis of permeability barriers and can be 'leaky' or 'tight' in nature.

INSECT GAP JUNCTIONS: STRUCTURE AND BIOCHEMISTRY. Jan S. Ryerse, Department of Pathology, St. Louis University School of Medicine, 1402 South Grand Avenue, St. Louis, Missouri 63104 USA

Gap junctions (GJs) are aggregates of connexon particles which are comprised of connexin protein and through which ions and small molecules pass directly between cells. A class of connexin proteins unique to insects is suggested by structural differences between insect and vertebrate connexons and by the lack of cross-reactivity of vertebrate GJ antibody and nucleic acid probes with insect proteins and nucleic acids. In my laboratory, urea-sarcosine, NaOH and octylglucoside have been used to isolate and solubilize GJ-enriched subcellular fractions from insects for structural and biochemical characterization. A polyclonal antibody, raised against a protein electro-eluted from gels of insect GJ fractions, specifically labels isolated, native insect GJs at the EM level. The antibody stains a 40 kD protein on immuno-blots of GJ fractions from different orders of insects. Amino acid sequence analysis reveals that the N-terminus of the 40 kD protein shares no homology with vertebrate connexins or with any other protein. The results suggest that the 40 kD protein is an insect-specific GJ connexin protein and will be discussed with respect to previous studies of GJ-enriched fractions from arthropods.

GAP JUNCTIONS IN INSECTS: DEVELOPMENTAL PHYSIOLOGY. Stanley Caveney, (Department of Zoology, University of Western Ontario, London, Canada N6A 5B7.)

The presence of gap junctions, clusters of membrane channels that connect directly the cytoplasmic compartments of contacting cells, is essential for normal tissue growth and differentiation in insects. Gap junctions arise early during epidermal development and help to coordinate metabolic activity and maintain segmental domains. Gap junctions also form instantly between haemocytes when they flatten onto a glass substrate *in vitro*, a response analogous to the encapsulation of foreign objects by these cells *in vitro*. Cellular adhesion is triggered by the unmasking of adhesion molecules on the surface of haemocytes due to wound-induced alterations in the blood plasma.

Gap junctional communication is particularly important in developing insect tissues. The overall permeability of gap junctions both to ions and small organic molecules, as well as the ionic conductance of single channels, is considerably higher in insects than in vertebrates. Insect tissues, being basically two-dimensional (sheet-like) in construction, are well adapted to control mechanisms that involve signal transfer by diffusion from cell to cell. When, and over what range, these signals influence the tissue would be determined by the state of junctional coupling at the time. Insect tissues normally self-regulate their level of junctional coupling; this imposes internal control over diffusion-based signalling mechanisms influencing growth rates and pattern formation.

WHY CATERPILLARS DO NOT GROW SHORT AND FAT.
Michael Locke and David Carter, Department of Zoology, University of Western Ontario, London, Ontario, Canada, N6A 5B7.

The integument of a caterpillar consists of a cuticle that is structurally isotropic in the plane of the surface overlaying an epidermis and basal lamina. Between ecdyses the cuticle stretches so that the proportions of caterpillars are about the same at the end of the stadium as at the beginning. This introduces a paradox, since in a cylinder under uniform internal hydrostatic pressure, as in a caterpillar, the hoop stress is twice the axial stress. Stress in the integument of a caterpillar inflated by compressed hemolymph would be twice as great in the circumference as in the axis causing it to become progressively fatter in proportion to its length as it grows. That this does not happen implies that there is an asymmetry opposite to that generated by the internal hydrostatic pressure. We have found that axial folds allow caterpillar cuticle to extend more easily in the axis allowing uniform growth in spite of the greater hoop stress from internal hydrostatic pressure.

THE REGULATION OF GROWTH IN THE INTEGUMENT. Arthur Retnakaran (Forest Pest Management Institute, Forestry Canada, P.O.Box 490, Sault Ste. Marie, Ontario, Canada, P6A5M7) Regulation of growth in insects is for the most part directed at the mono-layered epidermis which periodically goes through a molting cycle where the old cuticle is replaced with a new one. Endocrine cues trigger a sequential response resulting in a cascade of gene expression and recently many of these events have been identified. Both juvenile hormone and ecdysone act at the transcriptional level and are responsible for expression as well as repression of genes in the epidermis. The physiological changes in the epidermis during growth and development have been elegantly studied using *in vitro* cultures of the integument and much of the *in vivo* morphological changes have been demonstrated. In addition, several chemicals screened for insecticidal activity have shown distinct effects on the integument and these observations have provided clues to the way in which growth is regulated. Benzoylureas, for instance, inhibit chitin synthesis during the molting cycle although the exact mechanism is not clearly understood. Various naturally occurring and synthetic analogs of juvenile hormone and ecdysone produce characteristic effects on the integument. Certain dibenzoylhydrazines have been shown to have pronounced ecdysone activity and can be demonstrated at the transcriptional level using probes of genes that have been characterized from the epidermis.

THE HORMONAL REGULATION OF DOPA DECARBOXYLASE GENE EXPRESSION
Kiyoshi Hiruma and Lynn M. Riddiford (Department of Zoology, University of Washington, Seattle WA 98195, U.S.A.)

Dopa decarboxylase (DDC) which converts dopa to dopamine is important for cuticular melanization and sclerotization in insects. In the epidermis, DDC mRNA increases at the end of the molt as the ecdysteroid titer declines. Culture of Day 2 4th instar larval epidermis showed that an initial exposure to 20-hydroxyecdysone (20-HE) followed by hormone-free medium was necessary for this increase. The continuous presence of 20-HE prevented the appearance of DDC mRNA. When protein synthesis was inhibited during the final 3 hr of this continuous culture with 20-HE, DDC mRNA increased. Thus, 20-HE suppresses DDC mRNA expression via stimulation of a short-lived inhibitory protein(s), presumably a transcription factor. Sequence analysis of the promoter region of the Manduca DDC gene shows a 19 bp region of 79% identity with that of Drosophila DDC (AAAATATGATAGTGTGCAT) and contains a TGCA sequence that is necessary for repression of a Drosophila glue protein gene. Presently we are using a combination of gel retardation and in vitro transcription assays to determine the possible role of this and/or other sequences in the ecdysteroid regulation of this gene.

UNIFIED MECHANISM FOR SCLEROTIZATION OF INSECT CUTICLE. Manickam Sugumaran (Department of Biology, University of Massachusetts, Harbor Campus, Boston, Mass 02125, USA)

Sclerotization of insect cuticle is a vital process for the survival of insects. During this process, cuticular components such as chitin and proteins are cross linked by sclerotizing agents to form a hardened and often tanned cuticle. To account for the hardening reactions, three different molecular mechanisms have been proposed so far. These are quinone tanning, ß-sclerotization and quinone methide sclerotization. However, when N-acyldopamines are used as the sclerotizing precursors, all three mechanisms seem to be interconnected. N-acyldopamine quinone generated by the action of cuticular phenoloxidase participates in quinone tanning or serves as the substrate for the newly discovered quinone isomerase which produces transient N-acyldopamine quinone methide quinone. Quinone methide participates in quinone methide sclerotization and serves as the substrate for N-acyldopamine quinone methide: N-acyl dehydrodopamine tautomerase. The dehydrodopamine derivative thus formed after further oxidation by cuticular enzymes participates in ß-sclerotization. Evidence for the quinone methide participation in the last two processes will be presented.

CUTICLE PERMEABILITY IN RELATION TO STRUCTURE. J. Noble-Nesbitt (School of Biological Sciences, Univ. East Anglia, Norwich, UK).

The cuticle is highly impervious to water, the principal barrier residing in the lipid layer of the epicuticle that effectively determines the water permeability of the cuticle as a whole. Breaching of this layer can increase water movement through the cuticle very significantly.

Recent improved measurements on living insects combined with rigorous recalculation of permeability and diffusion coefficients has shown that the imperviousness of the cuticle to water is an order or two greater than previously thought. This indicates a very high order of molecular packing throughout the lipid layer, not just in an interfacial monolayer. Cockroach epicuticular grease is rich in hydrocarbons. It shows permeability characteristics similar to those of a solid wax rather than to those of an oil as might have been expected. Such molecular packing probably requires an organising force, possibly an hydrostatic force generated in the cuticle under the control of the epidermis and modulated by endocrines. A distinct phase change over a narrow critical (or transition) temperature range indicates the presence of a closely homogeneous class of lipid in the barrier layer. Phase changes at other temperatures and chemical analyses show the composite nature of the barrier lipid. Modulation of its permeability could be brought about by the addition or loss of mobile small lipid molecules.

Secretion of fluid from the openings of dermal (sweat) glands onto the surface of the cuticle in some terrestrial cicadas at high (near lethal) temperatures substantially increases the transpiration rate and provides essential evaporative cooling. Similar breaches in the epicuticle probably occur in all insects at the moult, particularly at the openings of the pore canals and dermal gland ducts, before the lipid layer is completed, so allowing essential transfer of material at this stage.

The Electrical Properties of Cuticle
Jacob S. Ishay and Amir Ben-Shalom
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Electrical and physical phenomena have been recorded and measured in the cuticle of the Oriental hornet Vespa orientalis. Active or narcotized live hornets as well as dead ones produce, at optimal temperature for vespinae biological activity, voltages of several hundred mV, currents of up to several hundreds of nA. and the appropriate electric power. The cuticle has a large electric capacitance relative to their volume and contain non-linear and active electrical elements. A theoretical model is proposed to explain the capacitance phenomenon. Additional phenomena observed are the production of electric energy under the influence of light and heat and also change in the various other electric properties of hornet cuticle under the influence of solar irradiation. The distribution of daily hornet activities seems to be correlated with the hours of maximal irradiation. All the afore-mentioned phenomena point to the fact that there is recourse to electric energy in the daily routine of hornets and that this electric energy seems to derive from solar energy. The conversion of the latter into the former takes place in the body of the hornet which thereby functions in the manner of a solar cell.

THE INFLUENCE OF BUPROFEZIN ON CUTICULAR CHITIN AND PROTEIN. A. De Cock & D. Degheele (Laboratory of Agrozoology, Coupure Links 653, B-9000 Gent, Belgium)

Buprofezin ('Applaud'), an insect growth regulator, acts specifically against sucking insects such as whiteflies, planthoppers and scales. Apparently the compound disturbs the normal moulting process in a similar manner as benzoylphenylurea. Electron microscopic observations show an amorphous pharate cuticle in treated whitefly nymphs, strongly varying in thickness and epidermal cells containing unusual structures. Localisation of chitin using a gold labelled lectin (wheat germ agglutinin which binds specifically to N-acetyl-glucosamin containing polymers) reveals a heavily labelled procuticle in untreated nymphs while in treated ones this zone was slightly labelled or devoid of label depending on the concentration used. No appreciable effect of buprofezin could be observed on the deposition of pre-ecdysial cuticle.

Electrophoretic separation of proteins on polyacrylamide gels does not reveal qualitative differences in protein bands between treated and untreated nymphs.

Above mentioned results indicate that buprofezin has at least partially the same mode of action as the benzoylphenylurea on nymphal stages.

PREPARATION OF ANTIBODIES AGAINST FIMBRIAE OF *XENORHABDUS NEMATOPHILUS* AND THEIR USE AS PROBES IN ULTRASTRUCTURAL AND CLONING STUDIES. Keith Binnington (CSIRO Division of Entomology, GPO Box 1700, Canberra, Australia 2601)

The capacity of entomopathogenic nematodes to kill their hosts is dependent on bacterial symbionts released by the nematodes into the bodies of insects. In most cases the association between the symbionts and nematodes is highly specific. Understanding the molecular interactions governing this specificity between symbiotic bacteria and nematodes would provide a basis for genetically manipulating strains of bacteria and nematodes to improve production efficiency of nematodes for insect control. *Xenorhabdus nematophilus* is the only bacterium retained within the infective stage of the nematode *Neoplectana carpocapsae* and occupies a specialised vesicle of the nematode intestine. It is known that many other bacteria belonging to the family Enterobacteriaceae attach to particular surfaces by fine hair-like fimbriae. That this is likely to be the case also for *Xenorhabdus* is underlined by the fact that it exists in two phases and only the fimbriated phase occurs naturally in infective juveniles.

In the first part of this study *Xenorhabdus* fimbriae have been purified by density gradient centrifugation and urea extraction, and polyclonal antibodies raised against them. These antibodies are being used to probe a *Xenorhabdus* genomic library for fimbrial genes and through the use of immunoelectron microscopy to confirm that bacteria within the gut vesicle are fimbriated.

STRUCTURE AND FUNCTION OF LEPTINOTARSA DECEMLINEATA EGG-SHELL. Issidora S Papassideri and Lukas H Margaritis, (Dept of Biology, Athens University, Panepistimiopolis, Athens 15701, Greece).

The Coleopteran, *Leptinotarsa decemlineata*, is known as the "Colorado potato Beetle". It is one of the most important parasites of potato cultivation. The insect deposits a large number of eggs on the surface of potato leaves and after hatching the larva destroys them.

The fine structure of *Leptinotarsa decemlineata* eggshell was studied by transmission and scanning electron microscopy, optical diffraction and computer reconstruction.

A mature follicle consists of the oocyte and the surrounding eggshell layers. The outer surface of the eggshell seems very soft but the inner is rough as revealed by scanning EM. The oocyte is surrounded by the vitelline membrane which is covered by a wax layer. This in turn, is surrounded by a crystalline chorionic layer which is 8500 A thick and has a periodicity of 110 A. Analysis of the crystalline layer by means of optical diffraction and computer reconstruction has shown that the parallel striations possibly reflect a helicoidal arrangement of the component molecules.

Experiments are in progress to clarify the way the eggshell layers are produced and self-assemble so that a possible control over embryogenesis might be achieved.

EGG CHORION ARCHITECTURE IN STICK INSECT. Mazzini M. (Department of Plant Protection, University of Tuscia, 01100 Viterbo, Italy)

In recent years it has become clear that there is a close relationship between egg chorion architecture as observed by scanning electron microscopy (SEM) and animal taxonomy and phylogeny. SEM studies have provided reliable information on many species groups in several insect orders, including Phasmatodea. Chorionic details often even reveal subspecific differentiation. Ultrastructural analysis by transmission electron microscopy (TEM) of the follicular epithelium during egg shell formation allow follicle cell secretory activity during chorionogenesis to be related to the different chorionic envelopes.

In this study a detailed description of the chorionic architecture of many stick insect species is given with special emphasis to the fine sculpture of the egg capsule.

Evolution of Lepidopteran Chorion Genes

Jerome C. Regier[1,2], Robert F. Leclerc[1], Brian M. Wiegmann[2] & Timothy P. Friedlander[1]

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Chorion sequences from two silkmoths (superfamily Bombycoidea) have been analyzed by maximum parsimony methods. The distribution of character state changes on the most parsimonious trees has been interpreted in terms of two evolutionary processes -- descent with modification and gene conversion. These processes may be distinguished at different depths, i.e. timeframes, on the tree.

Evolutionary and developmental analysis of chorion sequences has been extended to the gypsy moth (superfamily Noctuoidea). Gene family structure differs from that in silkmoths in interesting ways, but similarities in the mapping of character state changes on the tree suggest similar underlying processes.

STRUCTURAL, BIOCHEMICAL, AND MOLECULAR STUDIES OF *BOMBYX MORI* CHORION MUTANTS. M. R. Goldsmith, D. Gautreau, M. G. Alexopoulou (Department of Zoology, URI, Kingston, RI 02881-0816, USA), and G.D. Mazur (Harvard University).

Gr^{16}, a classic opaque, grey egg mutant of the silkworm mapping at locus 2-6.9, produces a chorion in which the inner lamellae are oriented perpendicular instead of parallel to the egg surface. Mature eggshell protein composition and developmental synthesis patterns appear normal, as do Southern blots probed with sequences for known chorion multigene families, indicating that Gr^{16} affects neither bulk chorion proteins nor involves a major deletion of structural genes. However, a minor, early protein doublet shows genotype-specific isoelectric forms whose amino acid labeling behavior is consistent with a mutation in its primary structure which affects post-translational modification. We will propose a general model to explain the morphological and biochemical defects of this mutation, and describe studies using a nested set of sex-limited chromosome 2 translocations encompassing the chorion structural genes which, in combination with the Gr^{B} deletion, show that the high cysteine (Hc) genes encode the lamellate outer crust.

MOLECULAR ARCHITECTURE OF HELICOIDAL PROTEINACEOUS EGGSHELLS

Stavros J. Hamodrakas
(Department of Biology, University of Athens, Athens 157.01, Greece)

Several extracellular fibrous structures, frequently proteinaceous, are known to have helicoidal architecture, a biological analogue of a cholesteric liquid crystal. From theoretical (secondary structure prediction, Fourier analysis of periodicities in protein primary structure, computer modelling) and experimental (X-ray diffraction, laser-Raman and infrared spectroscopy, freeze-fracturing) studies on the silkmoth eggshell, we have recently proposed the twisted antiparallel β-pleated sheet as the protein molecular conformation which dictates the formation of the helicoidal architecture in proteinaceous eggshells. Experimental evidence from electron microscopy, X-ray diffraction, laser-Raman, infrared and C.D spectroscopic studies indicates that our proposal is also valid for the helicoidal architecture of other eggshells including those of the lepidopteran insects *Manduca sexta* and *Sesamia nonagrioides*, and of the fishes *Salmo gairdneri* and *Dicentrarchus labrax*.

Roles of the cytoskeleton in early Drosophila embryogenesis
R.M. Warn School of Biology, University of East Anglia, Norwich, NR4 7TJ, U.K.

The changing organization of the cytoskeleton will be described and discussed for the period of early Drosophila development up to cellular blastoderm formation. Particular emphasis will be given to the different patterns of organization which form the pole cells and the blastoderm cells. The interactions of the different components to form the two cell types will be considered.

THE ROLE OF A CYTOPLASMIC FACTOR IN POLE CELL FORMATION AND GERM LINE DETERMINATION IN *DROSOPHILA* EMBRYOS. Masukichi Okada, Satoru Kobayashi (Institute of Biological Sciences, University of Tsukuba, Tsukuba 305, Japan), Ko Hatanaka (Department of Pharmacology, School of Medicine, Kitasato University, Sagamihara 228, Japan)

Pole cells or presumptive germ line cells in *Drosophila* are regulated by polar plasm for their construction and determination as the germ line. We screened a cDNA library generated on poly(A)$^+$RNA prepared from the early cleavage embryos of *D. melanogaster*. As a result, we obtained a clone including a sequence for a transcript that can restore pole-cell-forming ability to u.v.-sterilized embryos when injected immediately after the u.v. irradiation. This sequence was almost completely identical to the mitochondrial large ribosomal RNA gene of *D. yakuba*. Predicted roles of this RNA will be discussed, with reference to the cytoskeletal construction in the polar plasm region.

Pole cells were found to have already been furnished with such properties of germ cells as reported in the adult flies to splice the third intron of P-element. The splicing activity in pole cells was highest at the stage of their migration out of proctodaeal pit. Furthermore, the splicing activity was not distributed to all pole cells. Pole cells with this splicing activity all accumulate in gonads. However, none of the pole cells that remained outside gonads showed the splicing activity.

ORGANIZATION OF THE CYTOSKELETON DURING CELLULARIZATION IN *DROSOPHILA MELANOGASTER* EMBRYOS: ELECTRON AND CONFOCAL LASER SCANNING MICROSCOPY. *Kazuo Katoh* (Dept. Neuroscience, Osaka Bioscience Institute, 6-2-4 Furuedai, Suita, Osaka 565, Japan), *Harunori Ishikawa* (Dept. Anatomy, Gunma Univ. Sch. Med., Maebashi, 371 Japan).

The organization of cytoskeletal components in the early *Drosophila* melanogaster embryo during cellularization was examined by electron and confocal laser scanning microscopy.

At the late telophase of the last nuclear division in the syncytial blastoderm cortex, astral microtubules were identified by both electron and confocal laser scanning microscopy, and some of them were seen to run toward the surface plasma membrane at the area where a new cleavage furrow was expected to form. In electron microscopy, when embryos were fixed with phalloidin-containing aldehyde fixative to stabilize labile actin filaments at the starting stage of cleavage furrowing, many fine actin filaments were observed under the invaginating surface plasma membrane in scattered form. During cellularization, many microtubules were arranged around the nucleus extending from centrosomes. In some sections, microtubules were seen to run toward the surface plasma membrane, with which they appeared to be associated through microfilamentous aggregates suggesting an association between microtubules and actin filaments. When the invaginating tip reached beyond the nucleus, a contractile ring was formed at the tip of cleavage furrow parallel to the embryo surface. In confocal microscopy, the staining of α-actinin and myosin antibodies was exactly superimposed on that of FITC-labeled phalloidin. The results suggest that these proteins constitute a well-developed actin-myosin system as the contractile apparatus. Thus, the cytoskeletal components have crucial roles for formation of cleavage furrows and contractile rings during cellularization of the *Drosophila* embryo.

CELLULARISATION OF THE *DROSOPHILA* EMBRYO; FUNCTION OF THE BLASTODERM-SPECIFIC *SERENDIPITY ALPHA* GENE. Alain Vincent, Saad Ibn Souda (CRBGC-CNRS, Toulouse 31062 cedex, France), François Schweisguth (Institut Jacques Monod, Paris 75251 cedex, France).

The synchronous cellularization of the *Drosophila* embryo at the blastoderm stage provides a unique system for studying molecular mechanisms involved in cytokinesis. Genetical analysis indicates that this process requires the products of a limited set of zygotically acting genes, in addition to the major components of the cytoskeleton which are provided maternally. Among the zygotic genes, *serendipity α* encodes a membrane associated protein which is exclusively accumulated during cellularisation of the embryo and at no other developmental stage. Data will be presented on the the intracellular localisation of the *serendipity α* protein, its potential role in the reorganisation of microfilaments at the onset of cellularisation, and the control of *serendipity α* expression at the transcription level.

THE INTERMEDIATE FILAMENT CYTOSKELETON IN EARLY DROSOPHILA EMBRYOGENESIS. Harald Biessmann, and Marika F. Walter (Developmental Biology Center, Univ. of California, Irvine, CA 92717, USA).

Early Drosophila embryos contain maternally provided proteins that are immunologically and biochemically related to the intermediate filament cytoskeletal proteins of vertebrates. The proteins are located in the subcortical cytoplasm and form filaments of 10 nm diameter. We have studied the distribution and rearrangementss of this cytoskeleton during early cleavage stage in correlation to other cytoskeletal elements, microtubules and microfilaments. Moreover, the intermediate filament cytoskeleton is sensitive to heat shock and anoxia, which cause it to collapse at the nuclei. Embryos before cellular blastoderm are irreversibly arrested in development by heat shock, at or after cellular blastoderm development stops but continues when the embryos are returned to 25^{o}C. We will discuss the possibility that this rearrangement of the intermediate filament cytoskeleton may be involved in heat shock-mediated phenocopy induction.

AN ANALYSIS OF THE CENTROSOME DURING EARLY EMBRYOGENESIS IN DROSOPHILA MELANOGASTER. William G. F. Whitfield (Department of Biological Sciences, The University, Dundee DD1 4HN, UK) and David M. Glover (Department of Biochemistry, The University, Dundee DD1 4HN, UK).

A monoclonal antibody, Bx63, that specifically recognises the centrosome in Drosophila embryos has previously been described (Frasch, 1985). We have used Bx63 to screen libraries of Drosophila DNA in the expression vector lambda-gt11 and have identified a gene encoding a centrosome associated protein (Whitfield et al., 1988). Polyclonal antisera directed against defined domains of the centrosome associated protein have been prepared using polypeptide antigens derived by expression of selected sections of the cloned cDNA expressed in E. coli. These antisera have been used to characterise the distribution of the centrosomal antigen during syncytial and early cellular stages of Drosophila embryogenesis, to analyse the behaviour of the centrosome under conditions that disrupt mitosis and to investigate centrosome behaviour in several mitotic mutants. Experiments are in progress to identify the function of the centrosome associated protein and to isolate other components of the centrosome.

NONMUSCLE MYOSINS DRIVE CELL SHAPE CHANGES FOR *DROSOPHILA* DEVELOPMENT. Daniel P. Kiehart (Department of Cellular and Developmental Biology, Harvard University, Cambridge, MA 02138; new address starting 7/1/92, Department of Cell Biology, Duke University Medical Center, Durham, NC 27710, USA).

The focus of our research is to describe the molecular basis of cellular movements and shape changes that drive morphogenesis during embryonic development of *Drosophila*, where we supplement classical biochemical and cell biological approaches with powerful molecular biological, genetic and transgenic methods. Our studies show that nonmuscle myosins play a key role in cell shape changes during fly development: genes for the polypeptide subunits of native myosin have been cloned and mutations in the heavy and regulatory light chains have been recovered. Analysis of living embryos and fixed specimens were used to examine the phenotype of mutant embryos. The studies reveal that the heavy chain is a molecular motor required for cytokinesis and cell shape change during development, and that the regulatory light chain, whose state of phosphorylation regulates native myosin's ability to produce force, functions as a molecular switch that is required for cytokinesis. Both mutations have been rescued by transgenic methods and we are coupling site directed mutagenesis with transgenic methods to systematically examine the relationship between the structure and function of each of myosin's subunits. We are now turning our efforts to identifying the protein components of the cellular machinery into which myosin integrates to produce force for cell shape change and movement. We expect our studies on the molecular mechanisms of cell shape change to converge with other studies on the progressive expression of genes that specify pattern in the fly, ultimately allowing a detailed, molecular description of morphogenesis.

In vitro Activities and *in vivo* Function of an Unconventional Myosin from *Drosophila*. K. G. Miller[+], K. Kellerman [+], J.G. McNally*[+] and V. Mermall[+], [+]Department of Biology and *Institute for Biomedical Computing, Washington University, St. Louis, Mo. 63130.

We have identified and are studying the function of a new myosin family protein in *Drosophila melanogaster*, D95F myosin. We have cloned the gene for this protein and characterized its expression pattern. There are several alternate protein coding forms of the molecule expressed. By immunofluorescence in fixed embryos, this protein is localized to particles that are present in the cortical cytoplasm during the syncytial stages of development. We can observe the particles in living embryos by injection of small amounts of fluorescently-labelled anti-D95F myosin mAb. The injected antibody localizes to the particles and when observed in time-lapse, the particles move in a non-random fashion. This motion is sensitive to cytochalasin, but is not altered by colchicine, indicating the motility is actin-based. In a parallel approach, we are studying the *in vitro* activities of the protein. We can obtain a fraction enriched in the D95F myosin -containing particles and we have partially purified the protein from Drosophila embryos. The protein is an ATP-sensitive actin-binding protein, with a heavy chain of ~140 kD. In the most pure preparations, other known myosins are absent and D95F myosin accounts for ~90% of the protein, with one other prominent polypeptide of approximately 70 kD. This contaminating polypeptide co-purifies through a wide variety of chromatographic steps, including anti-D95F myosin antibody-affinity chromatography. We are investigating the possibility that this polypeptide is associated with D95F myosin *in vivo*. The most pure fraction has ATPase activity, and in preliminary experiments, this activity is stimulated by actin. We are studying the motility of the purified protein and the D95F myosin-containing particles *in vitro*.

GENETIC MECHANISMS OF NEUROGENESIS IN DROSOPHILA MELANOGASTER J.A. Campos-Ortega. Institut für Entwicklungsphysiologie. Universität zu Köln. Gyrhofstr. 17, 5ooo Köln 41, Federal Republic of Germany.

The neurogenic ectoderm of insects contains an initially indifferent population of cells which during later development will give rise to the progenitor cells of the neural and epidermal lineages. Experimental evidence indicates that cellular interactions determine which cells will adopt each one of these fates. In Drosophila, these interactions are likely to be mediated by the products of several genes forming a complex network of functional interrelationships.

Main elements of this network are (i) two groups of DNA-binding proteins, encoded by the achaete-scute complex and other still unknown genes, and by the Enhancer of split complex, which control the neural and epidermal development pathway, respectively. (ii) Two transmembrane proteins, encoded by the genes Notch and Delta, are likely to convey signals from one cell to another by means of direct protein-protein interactions. Commitment to a given developmental fate results when one of the two groups of regulatory proteins predominates in a given cell.

EVOLUTION OF THORACIC STRUCTURES IN THE PHYLOGENY OF DOLICHOPODIDAE (DIPTERA, EMPIDOIDEA). Hans Ulrich (A. Koenig Research Institute and Museum of Zoology, 5300 Bonn, Germany)

The morphology of thoracic skeleto-muscular systems in the dipteran family Dolichopodidae and its closest outgroups may serve as a model for understanding step-by-step evolution of a complex set of characters. The groundplan of the dolichopodid thorax exhibits numerous apomorphous character states, some of which are shared, in a varying extent, by the "Microphoridae", an obviously paraphyletic assemblage of seven genera, which were formerly included in the Empididae but are actually considered to be more closely related to the Dolichopodidae than any other known representatives of the Empidoidea. The character distribution among these genera suggests that evolution has proceeded from the common empidoid groundplan via "microphorine" and "parathalassiine" stages to the entire set of apomorphies as found in the Dolichopodidae. These findings strongly support the hypothesis of dolichopodid phylogeny as first proposed by Colless, 1963 and Hennig, 1971, and allow location of the systematic position of the relevant genera which have been subsequently discovered.

MORPHO-FUNCTIONAL ADAPTATIONS OF ADULTS IN THE DIPTERA ANDTHEIR EVOLUTIONARY PATHWAYS. V.F. ZAITZEV (Zoological Institute, Russisan Academy of Sciences, St. Petersburg, 199034)

It is shown with reference to the Bombylioidea, one of the major superfamilies of the Diptera, that the process of change for nectarophagy and perfection of flight determined to a great extent the type of morpho-functional coadaptations of a number of structures and organs in the adults. The author analyses the dynamics of correlations between proboscis length and a complex of morphological characters including shape of the head capsule, occipital foramen, development of the maxllary sclerite, presence or absence of the occipital chambers, development of the clypeal region, structure of some areas of the cervical part and prothorax, and some other characters.

CONSTRUCTIONAL DIVERSITY AND EVOLUTION OF INSECT CIRCULATORY ORGANS. G. Pass, H.W. Krenn, A. Hantschk (Institute of Zoology, University of Vienna, A-1090 Vienna, Austria)

In addition to the tubular dorsal heart insects have small autonomous circulatory pumps to supply long body appendages with hemolymph such as the antennae, legs, wings, cerci and elongated mouthparts. These accessory circulatory pumps are suitable models for neurobiological studies, but deserve also special attention from the constructional and evolutionary points of view. Comparative investigations reveal a high diversity in structure and function of these auxiliary hearts. The unexpected wide range is demonstrated by examples from various insect orders and contrasts to the uniform anatomy of the tubular dorsal heart. Special attention is given to questions of organ transformation during evolution. Some cases strongly indicate that structures from other organ systems have been recruited for modifications in the construction of the accessory circulatory pumps.

ULTRASTRUCTURE OF ANTENNAE OF THE ADULT RICE WATER WEEVIL, LISSORHOPTRUS ORYZOPHILUS KUSCHEL (COLEOPTERA: CURCULIONIDAE). Atsushi Mochizuki (Tohoku National Agricultural Experiment Station, Omagari, Akita014-01, Japan)

Sensilla on the antennae of adult rice water weevils were studied with scanning and transmission electron microscopes to determine the sensilla structure and possible chemo- and mechanoreceptive functions for host selection. Sensilla occur only on the top of three segments of the antenna and the other segments are smooth. Two main types, sensilla trichodea and basiconica have been classified. Sensilla basiconica were mainly found radially around the perimeter of each club segment and small type of basiconica were located on the top segment. The fine structure of the sensilla suggests four types of olfactory receptors, which were characterized by the numerous dendrite branches in the lumen and the numerous pores in the thin cuticular wall. Distribution of these sensilla on the club is discussed in comparison with that of the other curculionid beetles reported.

ON THE PRESENCE OR ABSENCE OF THE ABDOMINAL STERNITES VIII AND IX IN THE FEMALE IMAGO OF PTERYGOTE INSECTS. Thierry Deuve (Muséum National d'Histoire Naturelle, Laboratoire d'Entomologie, 45 rue Buffon, 75005 Paris, France).

The recent discovery of some cave-dwelling Coleoptera of the family Paussidae showing, at the imaginal stage, neotenic female genitalia, gave the opportunity to propose a new interpretation of the cuticular morphology of the postabdomen in the order Coleoptera. In this scheme, which has been generalized to all Holometabolous Insects, the sternites VIII and IX are not visible in the imaginal stage because they have participated to the elaboration of the internal genital ducts.

The question is presently to know to which extent this interpretation could be generalized to all Pterygote Insects.

USING A PERSONAL COMPUTER TO ANALYZE THE VENATION OF TORTRICINAE (LEPIDOPTERA). Jing-dong Liu (Entomology Laboratory, Department of Agriculture, University of Osaka Prefecture, 591, Japan)

As an attempt to select morphological characteristics which can be directly used in computers and to seek the appropriate treatment methods, computer image processing techniques were used to analyze the venation of insects. Specimens and materials of leafrollers (Lepidoptera, Totricinae) of Japan were chosen for analysis. The hardwares used in the study were EPSON PC-286 personal computer and EPSON GT-1000 image scanner, and the softwares were developed using TURBO PASCAL Version5.5 (MS-DOS). The designated positions of points of intersection of veins were input into the computer. Then the computer made transformation of coordinates and compared the coresponding positions of points of intersection of veins of all the genera. As a result, there were significant differences among most genera, which indicates that measuring the positions of points of intersection of veins may be possibly a useful way for identification and classification. Moreover, because the sequence of data input is simple and data reappearence is strong, this method may be conducive to eliminating the difference in understanding due to the literal description, thus open up the way to a more objective and more practical computer identification and classificaton system.

ULTRASTRUCTURE OF THE ULTIMATE FOLLICLE OF THE OVARIOLE IN AN ADULT COCCINELLID. Xiang-chen Zhong (Institute of Zoology, Academia Sinica, Beijing 100080, China)

In the telotrophic ovariole of adult lady beetle, C.septempunctata, mature oocyte with yolk deposition develops only in the ultimate follicle. At the early stage of follicular development, the follicle cells are cylindrical in shape and their intercellular spaces are narrow. In their cytoplasm scatter many mitochondria and ER. The oocyte appears oval in shape, containing a great number of mitochondria and lipid droplets. Microvilli protrubing from the oocyte intertwine with those from follicle cells. As the follicle develops, microvesicles and minute yolk granules are observed in the peripheral cytoplasm of the oocyte. These granules migrate inward to form large yolk granules that become the major component of the mature oocyte. The follicle cells become flattened and their intercellular spaces are enlarged. At the phase approaching oocyte maturation, many mitochondria move to aggregate in the outer-cytoplasm of the follicle cell, while secretory granules, adjacent to the oocyte. These granules are released into the space between the oocyte and the follicle cell, where they appear as vitelline bodies which will be finally fused to form the vitelline membrane enveloping the oocyte. Chorionin is finally secreted to form the chorion. With insufficient diet, no yolk granule is formed in the oocyte. Neither secretory granules can be observed in the follicle cells. The oocyte is loosely in contact with the follicle cells.

EGGS MORPHOLOGY OF THELYMORPHA MARMORATA F. (DIPTERA, TACHINIDAE). Gaponov, Serge P.(Voronezh University, 394000 Voronezh, USSR)

Eggs of Thelymorpha marmorata F. was investigated by Scanning Electrone microscope. Egg is of microtype (l 0,29 mm, w 0,21 mm, h 0,12 mm), oval, ellowish-brown with delicate chorion. The dorsal surface is convex, thin. Plastron surface is represent by caves. Polygonal network is absent. The anterior egg pole with aeropylar zone, which is similar with the "maple leaf" in its form. Aeropylar is consist of 300-315 little resperative cripts. The ventral chorion part is concave and flattern. The micropylar is situated subapicaky on the anterior egg pole. The egg morphology of Thelymorpha marmorata F. is shown of new plastron type in the group of microtype tachinid eggs.

STUDY ON STIGMATIC ULTRASTRUCTURE OF COCCINELLIDS LARVAE. Chun-ling Zhang(Department of Plant Protection, Shandong Agricultural University, Taian 271018, China)

Scanning electron microscopic observations on ladybird larva stigmatic ultrastructures of 14 species in 6 subfamilies indicate that the stigmata on the thorax have similar structures to those on the lst to 8th segments of abdomen. They are mainly divided into two categories, protruding from and paralleling to integument in height. On top of stigma, 3 types of structure are found to function as filtrating or closing. The first one shows a semicircular valve in shap, its diameter is 1/2 wider than that of the stigma. The second type is a filter apparently structured of arc-fibrillae. The third one gives an appearence of radially lined bunches of fibrils with a projecting center. The properties of stigma and closing or filtrating structure are found to be of species speciality and related to feeding habits of the larvae. The species with stigma protruding from integument include Stethorus japonicum, Illeis cincta, Rodolia pumila and Verania discolor. The remained species have stigma paralleling to integument. The larvae of predatory species are characterized by stigma paralleling to integument and more developed filtrating structure, while cycophagous ones by that protruding from integument. It is suggested that the stigmatic structures play an important role in classification and evolution of coccinellids.

GENITALIC ARCHITECTURE AND ITS IMPACT ON REPRODUCTIVE BEHAVIOUR OF CHIRONOMIDAE (DIPTERA). Girish Maheshwari and Geeta Maheshwari (School of Entomology, St.John's College,Agra 282002, India)

Reproductive behaviour of Chironomidae consists of a chain of sign stimulus response reactions and begins with contact of sexes and ending in sperm transfer. Initial and final positions during mating and orientation is peculier in different groups of chironomidae. Rotation and flexion of male and female genitalia, position of sexes and process of mounting is further regulated by the structural modifications in the genitalia. Present paper consists the details of internal and external male and female genitalia and impact of these modifications on the orientation and position of sexes, rotation and flexion of genitalia.

NEW FINDINGS IN THE INSECT SPERM AXONEME. R. Dallai (Department of Evolutionary Biology, University of Siena, I-53100 Siena, Italy), B.A. Afzelius (Department of Ultrastructure Research, The Wenner-Gren Institute, Biology E4, Stockholm University, S-106 91 Stockholm, Sweden)

Insect spermatozoa, from Diplura and "Thysanura" to Diptera, have acquired a supplementary set of microtubules external to the basic 9+2 flagellar axoneme. Whereas the nine doublets and the two central singlet tubules contain a fixed number of protofilaments (pfs), the accessory tubules consist of from 13 to 20 pfs. In most orders 16 is seen, 13 pfs are found in Diplura, Ephemeroptera, Psocodea, and the higher Diptera; 17 pfs in Phasmatodea; 18, 19 or 20 pfs in Trichoptera. Variations also occur in the structure of accessory tubular lumen and in the extent of the intertubular, dense material. These variations must be considered in the evaluation of the phylogenetic relationship among the groups. Recent studies on insect sperm axoneme have allowed us to specify the exact localization of dynein arms on subtubule A of the doublets; they have also provided a better definition of the centriolar structure and of the origin of the aberrant doublets in the posterior region of some spermatozoa.

#1
Immunocytochemical Localization of Serotonergic Neurons in Postembryonic Brains of Pieris rapae L.

Bong-Hee Lee,Woo-Kap Kim[1],Kwan-Seon Kim[1],Chai-Hyeock Yu[2],Kye-Heon Jeong,Ye-Kyu Lee[3],Jin-Woong Chung[4] Dept.of Biology,Soonchunhyang Univ.,Korea Univ.[1], Inha Univ.[2];Korean Entomological Institute, Korea Univ.[3];Dept.of Anatomy,Catholic Medical College[4], Korea

The serotonin-immunoreactive(5-HTi)neurons have been investigated in the brains of larva,pupa and adult from Pieris rapae L. The brains contain respectively Ca.52 5-HTi neurons in 5-day-old larva,Ca.18 in 2-day -old pupa and Ca.118 in 1-day-old adult. The brains of the larva and adult show strong immunoreactivities to the anti-serotonin,but weak immunoreactivity in pupa. In larval brain,most of 5-HTi neurons project into central neuropil, in which 5-HTi fibers are greatly aborized. In pupal cerebral neuropil, small number of 5-HTi processes are included. The adult brain contain 5-HTi fibers in lateral protocerebrum, antennal glomeruli, and tritocerebral and subesophageal neuropils, in which most of 5-HTi fibers also show rich aborization. The adult brain has a few 5-HTi cell bodies in pars intercerebralis,indicating that some of them may secrete serotonin as a hormone.

#2
Ach, 5-HT, GABA-POSITIVE IMMUNOREACTIVITY IN *Apis sinensis* Smith BRAIN. Zhi-Min XU, Shu-Zhen SHI, Hong NING (Institute of Biophysics, Academia Sinica, Beijing 100101.)

The distributions of Ach, 5-HT, GABA -positive immunoreactive neurons in the brain and optic lobes neuropiles of *Apis sinensis* Smith and *Apis mellifera* were studied by immunocytochemical techniques. The results show that there are various neuronal clusters and neuropilar branching patterns in the three visual neuroplexuses, protocerebrum and deutocerebrum. A small number of Ach, GABA and 5-HT reactive somata locate at the lamina C-layer and the anterior margin of the medulla. They would be the amacrines and a few of the widefield tangential cells. Several Ach, GABA, 5-HT immunoreactive somata are found around the central complex and between the lateral calyx and the optic lobes as well.

In the medulla and lobula, the positive immunoreactive fibers show different stratiform distribution patterns. The density of the 5-HT immunoreactive fibers is lower. Those of GABA and Ach fibers are denser. A dense network of many 5-HT immunoreactive fibers surrounds both the mushroom bodies and the central body. The arborisations of the 5-HT immunoreactive fibers show a distinct varicose appearance, interconnect and cover wide areas within and between the neuropiles. The strong Ach immunoreactivity is found in the antennal lobe.

#3
ULTRASTRUCTURE OF THE HEMOCYTIC IMMUNE RESPONSES TO FOREIGN SUBSTANCES IN EUPREPOCNEMIS SHIRAKII.
Woo-Kap Kim (Department of Biology, Korea University, Seoul 136-701, KOREA), Byung-Soo Chang, Sung-Moon Yoe, Myung-Jin Moon (Department of Biology, Dankook University, Cheonan 330-714, KOREA)

Hemocytic immune responses to the introduction of foreign substances such as colloidal gold particles and polyester spun into the hemocoel of grasshopper, Euprepocnemis shirakii Bolivar, were studied using electron microscope. Injected gold particles were phagocytized by the plasmatocytes which occupied 28 % of total hemocytes, but the other kinds of hemocytes were not reacted. During this phagocytic response surface reaction of the plasma membrane, especially projection of cytoplasmic processes and formation of phagocytic vesicles were finished within 10 minutes after injection. Multilayered capsule around the spun was formed within 6 hours, and 3 types of hemocytes - granulocyt s(I), granulocytes(II), plasmatocytes - were involved in this response. The initial response of this encapsulation was lysis of granulocytes(I) on the surface of the implant, next the granulocytes(II) attracted to the reaction sites envelop the implants, and forming a multilayered capsule composed of three morphologically distinct regions.

#4
ICE-NUCLEATING ACTIVE AGENTS IN LARVAE OF THE RICE STEM BORER, CHILO SUPPRESSALIS WALKER (LEPIDOPTERA: PYRALIDAE) Hisaaki Tsumuki, Haruyoshi Konno and Takanori Maeda (Research Institute for Bioresources, Okayama University, Kurashiki 710, Japan)

The crystallization temperatures in the whole bodies and individual tissues of rice stem borer larvae, being a freezing tolerant species, were measured to elucidate the distribution of ice-nucleating active (INA) agents and further the INA agents characterized

In diapausing larvae the crystallization temperature of the muscle and epidermis was the highest, being above -15°C, which was the similar to that of the whole larvae. Consequently in diapausing larvae, a primary freezing site is present in the muscle and epidermis, indicating that INA agents exist in the tissues. In non-diapausing larvae the crystallization temperature of the gut with its contents was higher than that of the other tissues tested, showing that INA agent exists in the gut. INA agent was not produced from rice plant material as a food for the larvae. However, a fungus from a suspension of the gut with its contents had the INA and was identified as Fusarium sp. The fungal suspension increased the crystallization temperature of the larvae.

The active site of INA agent produced by the fungus was composed from protein and the protein was further characterized.

#5
PRELIMINARY OBSERVATIONS ON THE HOLOGRAPHIC APPEARANCES OF INSECT MORPHOLOGY. Feng-ming Yan (Department of Biology, Peking University, Beijing 100871, China)

The core of holographic biology is ECIWO theory. The theory points out that any relatively independent part (one segment, one branch, or one appendage) is similar biologically to and developing towards the body as a whole. And biological characters can generally be expressed by forms, structures, streaks and so on. In the present paper, the external and some internal structures of insects are studied with the theory of ECIWO biology. It is found that each ECIWO of an insect is composed of 3 (or 3 times) segments of parts in order to be correspondent with 3 segments of the whole insect body, and that the ECIWOs are similar to each other in different degrees. The insect symmetry and other problems are also discussed.

#6
ORIGIN AND FUNCTION OF THE CENTRIOLE ADJUNCT IN SPERMATIDS OF LOCUSTA MIGRATORIA MANILENSIS AND COCCINELLA SEPTEMPUNCTATA L.
Zong-shun Wang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The formation and role of Centriole adjunct (CA) in spermatids of L. migratoria and C.septempunctata are investigated by ultra-thin section and water spreading techniques. It is found that the CA as an electron dense body and the proacrosomal granule appear in the region between nucleus and the nebenkern. Later, the cylinder-like dense body which mainly consists of ~300 Å granules is attached to the nuclear membrane, of which the inner and outer components are then thicken. As the nebenkern differentiates into two mitochondrial derivatives or a bit earlier, the proximal centriole migrates to the CA and is finally surrounded by the latter. As a basal body, it is anchored on the nuclear envelope and the axoneme originates from it. Following the spermatid elongation, the shape of CA is progressively transformed and extended. It is most interesting that 250-300 Å chromatin figers along the lingitudinal axis of the spermatid are attached to the base of CA structure. As spermatid nucleus elongates, the chromatin fibers are unwound and joined together forming ribbon-like structure. It is assumed the CA is a transiant organelle and its role is to organize the rearrangement of the chromatin in the spermatid and to direct the migration of the centiole to the nuclear region from where the flagellum extends.

#7

ULTRASTRUCTURAL STUDIES ON THE SPERMATOZOA OF ARCHENOMUS LONGICORNIS (NIK.)(HYMENOPTERA: APHELINIDAE). Yinyue Hu, Chengde Li, (Northeast Forestry University, Harbin, 150040, China), Zhongqing Pi (Forestry Science Institute of Jilin Province, Changchun, China)

Archenomus longicornis (Nik.) is an important endoparasitic natural enemy of scale-insect Quadraspidiotus gigas (Thiem et Gerneck) in second instar larvae and female adults. The parasitic percentage is about 30% in Hailun county, Heilongjing province. In present paper, the ultrastructure of the spermatozoa of A. longicornis was studied with transmission electron microscopy. The sperm bundles are thread-like in shape, most of the bundles contain 128(=2) sperm per bundle and some contain 64(=2) or 256(=2). The sperm is also thread-like shaped and consists of head, neck and tail. The acrosome on top of the head is wedge-like shaped, put together with the anterior part of the nuclear core. Neck consists of nuclear core, centriole, 9+9+2 axoneme, mitochondrial derivatives and so on. There appear two accessory bodies in each mitochondrial derivatives. Tail consists of axoneme and two mitochondrial derivatives, and there are low electron dense materials around the mitochondrial derivatives, but on the surface where derivatives faced to axoneme are absent.

#8

ULTRASTRUCTURE OF THE ULTIMATE FOLLICLE OF THE OVARIOLE IN AN ADULT *COCCINELLID*. **Xiang-chen Zhong** (Institute of Zoology, Academia Sinica, Beijing 100080, China)

In the telotrophic ovariole of adult lady beetle, *C. septempunctata*, mature oocyte with yolk deposition develops only in the ultimate follicle. At the early stage of follicular development, the follicle cells are cylindrical in shape and their intercellular spaces are narrow. In their cytoplasm scatter many mitochondria and ER. The oocyte appears oval in shape, containing a great number of mitochondria and lipid droplets. Microvilli protubing from the oocyte intertwine with those from follicle cells. As the follicle develops, microvesicles and minute yolk granules are observed in the peripheral cytoplasm of the oocyte. These granules migrate inward to form large yolk granules that become the major component of th mature oocyte. The follicle cells become flattened and their intercellular spaces are enlarged. At the phase approaching oocyte maturation, many mitochondria move to aggregate in the outer-cytoplasm of the follicle cell, while secretory granules, adjacent ot the oocyte. These granules are released into the space between the oocyte and the follice cell, where they appear as vitelline bodies which will be finally fused to form the vitelline membrane enveloping th oocyte. Chorionin is finally secreted to form the chorion. With insufficient diet, no yolk granule is formed in the oocyte. Neither secretory granules can be observed in the follice cells. The oocyte is loosely in contact with the follicle cells.

#9

STRUCTURE AND FUNCTION OF LEPTINOTARSA DECEMLINEATA EGG-SHELL. Issidora S Papassideri and Lukas H Margaritis, (Dept of Biology, Athens University, Panepistimiopolis, Athens 15701, Greece).

The Coleopteran, *Leptinotarsa decemlineata*, is known as the "Colorado potato Beetle". It is one of the most important parasites of potato cultivation. The insect deposits a large number of eggs on the surface of potato leaves and after hatching the larva destroys them.

The fine structure of *Leptinotarsa decemlineata* eggshell was studied by transmission and scanning electron microscopy, optical diffraction and computer reconstruction.

A mature follicle consists of the oocyte and the surrounding eggshell layers. The outer surface of the eggshell seems very soft but the inner is rough as revealed by scanning EM. The oocyte is surrounded by the vitelline membrane which is covered by a wax layer. This in turn, is surrounded by a crystalline chorionic layer which is 8500 A thick and has a periodicity of 110 A. Analysis of the crystalline layer by means of optical diffraction and computer reconstruction has shown that the parallel striations possibly reflect a helicoidal arrangement of the component molecules.

Experiments are in progress to clarify the way the eggshell layers are produced and self-assemble so that a possible control over embryogenesis might be achieved.

#10

A STUDY ON THE MORPHLOGY OF THE MALE GENITALIA AND A APPLING IN THE PHYLOGENENSIS OF SCARABAEOIDEA (COLEOPTERA) Gu Yun (Department of Plant Protection, Laiyang Agricultural College, Laiyang, 265200, China)

Author studied the morphylogy of male genitalia of 348 species scarabaeoids belonged to 72 genera in 17 families of Scarabaeoidea. The relationship and evolutionary linea between 17 families were studied in accordance with the modification of the male genitalia. The phylogenesis tree was set up. The1 male genitalia of scarabaeoid is compised of two main parts: the genitalia cupsule or aedeagus theca that is changed from the genital segment and the aedeagus that from the object produced of the membrance of eighth sternus posteriorly. The aedeagus is divided into the outer tube been formed by the tegmen, and inner tube by the median lobe(penis) and internal sac. The result of studied indicated that it can been shown clearly the relationship between the different groups and evolutionary lines with the degree of morphological modifications of the male genitalia. Author is of the opinion in the Scarabaeoidea, that Geotrupidae is the lowest taxa and it is the ancestors of other scarabaeoids of families, and evoluted from it into two directions, and formed two branchs ----Lucanids branch and Scarabs branch.

#11

A HISTOMORPHOLOGICAL METHOD FOR THE PREPARATION OF THE 2nd AND 3rd LARVAL STAGES OF GASTEROPHILUS SPP.. Bné Egri, B.Egri (Department of Animal Phys. and Health, Pannon Univ.Agric.Sci., Mosonmagyaróvár, Hungary), M.Bieber (Department of Pathology, Karolina Hospital, Mosonmagyaróvár, Hungary)

The effect of different new larvicide (gasterophilocide) remedies controlable with measuring of excretion of larvae and/or with observation of histomorphological changes in the organism of larvae. However, the preparational process at the second and third larval stages of Gasterophilus spp. is too difficult. We proposed a simple method for preparation:

1., Fixation of excreted larvae in 10% sol. of formaldehyde (term: 10 days)
2., Cutting in half the larvae and further fixation in 10% sol. of formaldehyde (term: 16 hours)
3., Washing the larvae down (term: 30 min)
4., Dehydration:
   4.1. Propylic alcohol (96%)(term: 1 hour)
   4.2. Acetone with copper (II)sulfate, anhydrous (term: 4x1 hour)
   4.3. Xylene (term: 3x1 hour)
5., Encase in paraffin with bee-wax (proportion: 1:12,5)
6., Deparaffinization in xylene
7., Staining methods: Iron Haematoxylin and Pichrofuchsin (Van Gieson);
   Haematoxylin and Eosin

#12

DEVELOPMENT OF THE ANGOUMOIS GRAIN MOTH, *SITOTROGA CEREALELLA* (OLIVIER) ON DIFFERENT FOODSTUFFS OF DIFFERENT WATER CONTENT LEVELS, (LEPIDOPTERA: GELECHIIDAE). I. I. Ismail, A.K. El-Nahal (Dept. of Econ. Entom. Fac. of Agric., Cairo Univ., Egypt) and T.S. Mostafa (Plant Protection Instit., Ministry of Agric., Egypt).

The development of the angoumois grain moth, *Sitotroga cerealella* (Olivier) reared on different foodstuffs (i.e. wheat, maize, sorghum, paddy rice and milled rice) of different water contents, was studied. The water content of the indicated grains significantly affected the development of the immature stages of *S. cerealella*. The most suitable level of water content for development ranged from 13.8 to 15.8%. Milled rice was not favourable. Generally, the water content of grains gives an indication on the suitability of grains to infestation with insects.

#13
THE STUDY OF EMBRYOGENESIS OF *DACUS TAU* (DIPTERA: TEPHRITIDAE). Guohai Yang (Guangzhou Animal and Plant Quarantine Service, Guangzhou, China)

The embryogenesis of Dacus tau was studied by means of light microscopy and SEM. Under the temperature of about 25°C, the pole cells appeared at posterior pole at about 1.5hr. Three hours later, division and migration of the energids continued until energids reached periplasm to form syncytial blastoderm. Cellular blastoderm formed at about 4.5hr. After 5hr, cephalic furrow and vitellophages appeared. The formation of internal organs began at about 12hr. The Malpighian tubes was considered as entodermal origin. SEM was used to observe the development of the embryo from blastoderm to hatching, particularly the formation of the anal segment and the head including the labial segment, maxillary segment, mandibular segment and sense organs.

#14
HISTOLOGICAL STUDY ON THE FEMALE REPRODUCTIVE SYSTEM OF CHRYSOPA SEPTEMPUNCTATA WESMAEL. Tian-ye Chen, Ji-yuan Mu (Agricultural University of Shandong, Taian, Shandong 271018 China)

The ovarioles of the female reproductive system of Chrysopa septempunctata Wesmael are of the polytrophic type. There is one oocyte and 8 nurse cells in each follicle. A well developed ovariole consists of terminal filament, gemarium, previtellarium, vitellarium and pedicel. According to the changes of oocytes, nurse cells and follicullar cells in the ovariole, the process of oogenesis can be divided into ten successive stages, five for the previtellarium, and five for the vitellarium. Histologically, the lateral oviduct, median oviduct and vagina obviously differ in epithelial sizes, arrangements of muscles and intimas. The epithelium of bursa copulatrix is thin, but its intima is thicker with two layers. The muscles around the bursa copulatrix are arranged disorderly. The spermatheca is lined with a strongly sclerotized intima. The spermathecal duct can be divided into two parts histologically. The first part with two fractions, the crack of the front fraction opening into the bursa copulatrix, the crack of the back fraction opening into the vagina. The crack of the second part opens into vagina. The colleterial gland and the scent gland are different histologically. The functions of every part of the female reproductive system of Chrysopa septempunctata Wesmael are also analysed and discussed.

#15
A STUDY ON THE REPRODUCTIVE SYSTEM OF *Acleris fimbriana* Thunberg. Yongliang Fan, Guanglu Shi, Lizheng Li, Guoliang Zhang, Jie Li (Department of Plant Protection, Shanxi Agricultural University, Taigu 030801, Shanxi Province, China)

Acleris fimbriana Thunberg is belong to *Tortricidae, Lepidoptera*. It is one of the most important orchard's pests in north of China.

This paper deals with the anatomy of the reproductive system of the *Acleris fimbriana*. The internal and external organs of both sexes are described.

On the part of the male internal organs, there are a pair of testes; the two testes of opposite sides are closely united as a single round organ enclosed in a common crimson scrotum. The vasa deferentia are paired narrow tubes and the basal section of each vas deferens is twice enlarged to form the seminal vesicles. It is found that the ductus ejaculatorius includes the paired anterior part, the ducts ejaculatorius duplex, and the posterior single tube, the ductus ejaculatorius simple. At the apex of the ductus ejaculatorius duplex is situated a pair of accessory glands. The external genitalia of the male are composed of the phallus and garpes.

In the female, the intermal reproductive organs are composed of a pair of ovarioles, each of which consists of four polytrophic ovarioles. A pair of lateral oviducts unite posteriorly to form the oviductus communis, which is connected with the vestibule opening to the exterior by the oviporus. The receptaculum seminis is an peal — shaped organ from which arises the ductus communis. A pair of accessory glands is joined to the apex of two large accessory gland reservoirs. The external reproductive system in the female includes the bursa copulatrix and the ovipositor.

#16
STUDIES ON THE ONTOGENY OF ELENCHINUS JAPONICUS ESAKI ET HASHIMOTO (STREPSIPTERA): EGG PRODUCTION AND EMBRYO DEVELOPMENT. Xiu-hui Gu, Yawei Bei and Chunxian Gao (Institute of Plant Protection, Zhejiang Academy of Agricultural Sciences, Hangzhou 310021, China)

The Strepsiptera is exceptional among insects in that all of its species are Viviparous, embryos develop and hatch within hemocoel of females. Elenchinus japonicus belongs to Strepsiptera, Elenchidae. It parasitizes in Sogatella furcifera, Nilaparvata lugens and Laodelphax Striatellus. This paper reported that the each stages in egg production: 1) The female body of E. japonicus has not typical ovaries. The primitive eggs each and all within hemocoel of female are synchronic development and maturation. It is early found that the primtive egg is the cystoblasts in hemocoel of female. 2) The cystocytes consist of 256 sibling cells. 3) One sibling cell of the cystocytes differentiate into oocyte and rest become nurse cells (syncytia). 4) Mature eggs are elliptical, containing a lot of yolk, measuring 75-100×40-50 um in size. This paper also reported that the embryos developing process of E. japonicus include the stages of cleavage, blastoderm formation, segmentation of germ band, formation of appendage and the doral enclosure of embryo, and so on. It is clear that E. japonicus is monoembryonic species and the cleavage is total.

#17
EFFECTS OF ACOUSTIC TRACHEA SYSTEM ON THE AUDITORY NEURONS IN THE BUSHCRICKET *Gampsocleis gratiosa*. Jun-Xian SHEN (Institute of Biophysics, Academia Sinica, Beijing, China)

Bushcrickets show good capability for locating sound source even in bush or at dark. The results from identified auditory neurons demonstrate response threshold differences between ipsi- and contralateral stimulations are greater than the interaural intensity differences. The acoustic trachea system of the bushcricket is a special organ, comprising the spiracles, large vesicles and long tapering tubes bending through the coxa and femur of the forelegs. The system can be analogous to an exponential auditory horn, a frequency-dependent sound amplifier, with a maximum gain of ca. 28 dB. The threshold-frequency relationships for the auditory neurons are considerably different when the ipsilateral spiracle is blocked or not. The differences are about 20 to 30 dB in the frequency range from 7 to 18 kHz. There are no changes in the thresholds for the auditory neurons if only contralateral spiracle is blocked. The changes of directional sensitivity for an ascending neuron before and after blocking the ipsilateral spiracle show the anterior semicircle threshold difference curve is half-cardioid in shape with the difference of about 15 dB between the azimuth 90^{o} and -90^{o} when the system is intact. However, it is almost circular with the differences of less than 3 dB, when the spiracle is blocked.

#18
MALE SCENT ORGANS OF THE GENUS LOBESIA (LEPIDOPTERA, TORTRICIDAE). Y. S. BAE, Entomological Laboratory, University of Osaka Prefecture, Sakai, Osaka, 591 Japan.

The males of Tortricid genus Lobesia possess a pair of glandular abdominal pockets on the 2nd abdominal segment (actually the united 1st and 2nd abdominal sternite) and the hair pencil present on inside of the hind tibia. A correlation is observed between the degree of the development of tibial hair pencil and that of the abdominal pouches (Falkovitsh, 1962).

The hair pencil is present on dorsal base of hindwing only in the male of Lobesia (Lomaschizodes) siamensis Bae from Thailand. So far as I am aware, the presence of hair pencil of hindwing has not previously assessed for phylogenetic character and I believe that this structure and development of other secondary sexual structures appear to be closely related within subgeneric level.

#19

A STUDY ON THE OPTICS OF COMPOUND EYES OF INSECT. Meiying Wu, Weiguo Wu, Shuzhen Shi, Zhimin Xu (Institute of Biophysics, Academia Sinica, Beijing 100101, China)

The light that enters an eye through the cornea contains the information about the outside wortd. An eye involves a large of optical components so the optical information processing is necessory to sort the incoming photons to specific photoreceptors in theretina. It form an image on a retinal array of photoreceptors, which then constitutes a neural image of the outside world. There are five optical types of compound eye divided into two types of apposition eye and three types of superposition eye. In apposition eyes, ommatidia are optically isolated from each other, whereas in superposition eyes, they cooperated to form a bright superimposed image. The Keplerian and Galilean telescopes, the corner reflectors, light-guiding fibers and interference filters exist in various combination in the optics of insect compound eyes.

#20

PARAGLOSSAL SENSILLA, STYLET INNERVATION, AND THE PRECIBARIAL AND CIBARIAL SENSILLA, OF FRANKLINIELLA OCCIDENTALIS (PERGANDE) (THYSANOPTERA: THRIPIDAE). Wayne B. Hunter and Diane E. Ullman, Department of Entomology, University of Hawaii at Manoa, Honolulu, Hawaii 96822, U.S.A.

Scanning- and transmission- electron microscopy were used to examine the sensilla on the paraglossae, stylets, and anterior alimentary canal of the western flower thrips, Frankliniella occidentalis (Pergande).

Ultrastructural evidence suggests that some thrips paraglossal sensilla have a dual mechanosensory/ chemosensory function, while others are apparently solely mechanosensory. Mandible and maxillary stylets are innervated. The mandibular stylet contains a central dendritic canal, within which are 3 dendrites, and two lateral dendritic canals, each of which has 1 dendrite. Each maxillary stylet has 4 dendritic canals each containing a single dendrite. Within the pre-cibarium, which is located at the distal tip of the mouthcone, there are 4 chemosensilla. The cibarium contains 18 dorsal chemosensilla and 2 ventral chemo-sensilla, proximally located relative to the cibarial valve. The significance of these findings relative to thrips feeding mechanisms and the possible function of paraglossal, stylet and cibarial sensory structures in host location, feeding site selection and host choice are discussed.

#21

FINE STRUCTURES OF SENSILLAE , NERVES AND NEUROPILES OF ANTENNAE AND MOUTHPARTS IN THE COTTON BOLLWORM, HELIOTHIS ARMIGERA(LEPIDOPTERA:NOCTUIDAE). CHEN Hong (Dept. of Plant Protection, Beijing Agri. University Beijing 100094, China)

Fine structures of sensillae,nerves and neuropiles of antennae and mouthparts of 5th-instar larvae of the cotton bollworm,Heliothis armigera,were examined under SEM and TEM. 7 types of sensillae were identified according to their appearances. The peg innervated by 3 bipolar neurons on the distalia and the medial apical peg innervated by 4 bipolar neurons at the tip of maxillary palp are multiporous chemosensillae. The lateral styloconic sensilla innervated by 5 bipolar neurons on the galea is a uniporous contact chemoreceptor. In the antennal and maxillary nerves the sensory and motor axons arrange regionally. The sensory axons extend processes into the neuropiles where many synapses are formed.

The olfactory function differences of sensillae on the antennae and the maxillary palpi were investigated by cauterization. The statistical differences of 7 groups of cauterization were inspected at 1% level by t-test. The olfactory sensillae in pairs on both antennae are necessary for perception of the artificial diet and orientation to it, this function of the receptors at the top of the palpi is indistinct.

#22

SCANNING ELECTRON MICROSCOPE OF SENSILLAE OF ANTENNA AND MAXILLARY PALP IN ADULT SWEET POTATO WEEVIL, CYLAS FORMICARIUS FABR. Jian-xin Chen, hong-lian Li, Hong Chen (Beijing Agricultural University, Beijing, China)

Surface features of antenna and maxillary palp of sweet potato weevil, Cylas formicarius Fabr., were examined under a scanning electron microscope; There are trichoid sensillae, cudgel sensillae, basiconic sensillae and coeloconic sensillae on the maxillary palp according to the sensilla appearances. The cudgel sensillae existed on the antenna of sweet potato weevil have not been found ever before in other insects.

#23

AN OBSERVATION OF SOME SENSORY STRUCTURES OF ADULTS OF THE TINGIS FABRICIUS FROM INNER MONGOLIA UNDER SCANNING ELECTRON MICROSCOUP. QI Baoying, Nonnaizab (Biology Department, Inner Monglia Teachers University, Huhehot, 010022, China)

An observation on some sensory structures on body surface of adults of both sexes of 11 species of Tingis fabricius from Inner Mongolia were made under SEM, revealing some charcters of the structures and their importances in classification. The authors comparitively observed sensory nodules and sensory pits on both side of II-V tergums of abdomen in both sexes of 12 species adult lacebugs belonging to 2 subgenera T. Neolasiotropis and T. s.str.. A number of fifferences between the 2 subgenera, in terms of sensory structure density, distance between nodules, forms of smooth area without sensory structures and numbers of the sensory pits, were found. Most species of T. Neolasiotropis possess densely arranged sensory nodules, with less sensory pits. Small processes in the pits are ball-like, robust and bunchy. Smooth area irregular, margin indistinct. Most species of T. s.str. possess more scatter sensory nodules with space 2 times larger than its diameter. Number of sensory pits are more, small processes finger-like or ball-like, radiantly arranged. Smooth area regular round or ovate, margin uniform and distinct. In species level, forms, arrangements and numbers of sensory structures between related species are similar. Difference in number of sensory pits appears on III-IV tergum and difference on II, V tergum is very small.

#24

SCANING ELECTRON MICROSCOPY OF THE ANTENNAE OF *EPHESTIA CAUTELLA* . Dong-feng Cao (Handan college of Hebei 057150, China), Jing-yuan Xuan (Plant Protect Department, Sorthwest Agricultaral University, Chongqing 630716, China).

The antennae of *Ephestia cautella* Walker were observed with a scanning electron microscope. At least six kinds of sensilla , i.e., sensilla coloconica, sensilla slycoconica, sensilla trichodae, sensilla basiconica and sensilla chaetica, sensilla auritilla were discovered.

Sensilla coloconica have a cavity of 3~6 μm, dimeter and 9 ~12 edge-slycoconica. Only two withont any edge-slyconica were found on male's antennae.

Sensilla trichodae were the most numberous of the six types observed and evere divided into three subtypes, one of which is relatively straight and has a blunt tip; other of which is slender and has a curved tip. While the rest of which found on male's is wider and has a swelliny-olive-shuped strauture at the location from 1/7 to 2/7 of length at the top of the trichodae.

Sensilla auricillica generally occurs on male 's only and weresubdivided into three types (single , couple and triple) according to the numbed of auricillica (vertically rolling for spoon -shaped, 3~4 μm in wide, 5~7.5 μm in length) in the mortar (3~6 μm in diameter).

Besides, many holes arranging on the reticulate surface of the antennae were considered to be a sensilla just as sensepore.

#25

COMPARATIVE STUDIES ON THE ULTRASTRUCTURE OF ANTENNAL SENSILLA OF AEDES ALBOPICTUS, MUSCA DOMESTICA AND PERIPLANETA AMERICANA. Xuejun Huang, Caigui Cheng, Ruide Xue (Institute of Microbiology and Epidemiology, Beijing 100071, China)

The type, distribution and fine structure of sensilla on the antennal surface of A. albopictus, M. domestica and P. americana were studied by the scanning and transmission electron microscopy. The total number of antennal sensilla (♀/♂) of A. albopictus, M. domestica and P. americana are about 671/251, 1600/1600, 40334/55781; and divided into eight, seven, eight types respectively. A. albopictus has sensilla chaetica I, II; short and long pointed-tipped s. trichodea; blunt-tipped s. trichodea I, II; grooved s. basiconica and s. coeloconica. M. domestica has s. chaetica; s. trichodea; s. basiconica Ia, b, II; grooved s. basiconica I, II; s. clavate. P. americana has s. chaetica A, B; s. trichodea; s. basiconica; grooved s. basiconica; s. capitulum; campaniform sensilla and marginal sensilla. Three species all have s. chaetica, thick-walled multiporous s. trichodea, thin-walled multiporous s. trichodea or thin-walled multiporous s. basiconica, and grooved s. basiconica; while s. coeloconica, s. clavate, and s. capitulum, campaniform sensilla, marginal sensilla are specific sensilla and only present on the antennal surface of A. albopictus, M. domestica and P. americana respectively.

#26

ULTRASTRUCTURAL OBSERVATION ON THE AEROPYLES OF SEVEN SATURNIID SPECIES BY SCANNING ELECTRON MICROSCOPE. Jian Hong, Cui Hu and Gong-yin Ye(Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

The aeropyle structure of seven saturniid species was observed by scanning electron microscope. Results indicated that: there was a shield structure in the aeropyles with high crown of Antheraea pernyi and A.yamamai, and the aeropyle without crown of Eriogyna pyretorum. There was no similar structure in the aeropyle with low crown of A.yamamai,the aeroplye with cavity of Actias selene,the simple aeropyles without crown and cavity of Philosamia cynthia, P. cynthia ricina and Dictyoploca japonica. It is a very interesting case which hasn't been reported clearly nor in detail. This shield structure seems to exist in the aeropyle with larger opening. According to the ultrastructure and opening degree of the aeropyle, the authors incline to think that this shield structure may be a regulative device to control the degree of opening or shutting and perform an important function in respiration of larger egg during embryogenesis.

#27

MORPHOLOGY OF THE MIDGUT EPITHELIUM DURING THE METAMORPHOSIS IN GERMAN COCKROACH, BLATTELLA GERMANICA. Chai Hyeock Yu (Dept. of Biology, Inha University, Inchon 402-751, KOREA)

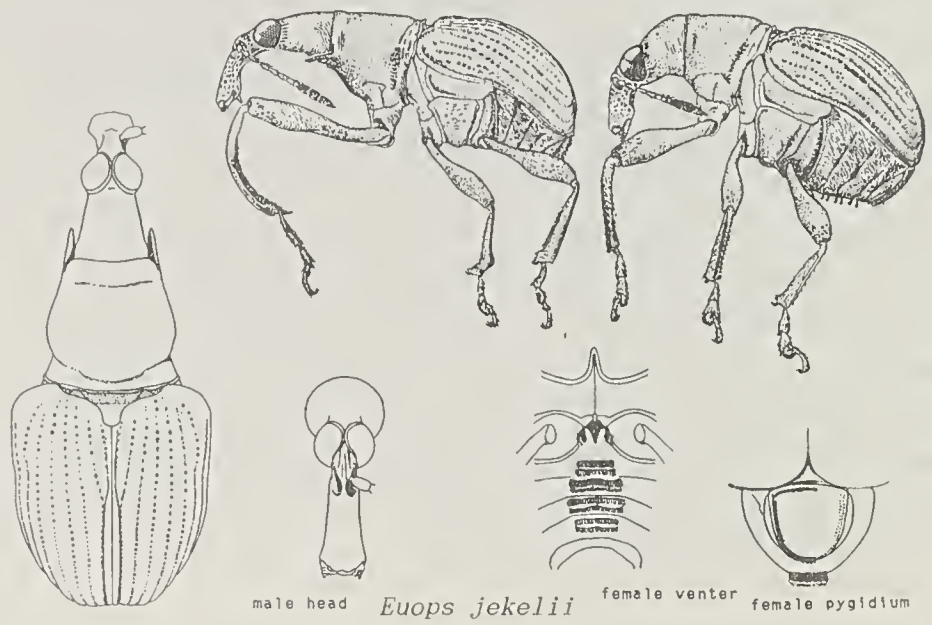
The histological changes of the midgut epithelium are comparatively observed at the proper metamorphosis stages during the period of last instar nymph to one day adult of the german cockroach, Blattella germanica. Midgut epithelium of the last instar nymph is composed of a single layered columnar cells and regenerative cells. The free surface of the columnar cells a regular array of microvilli "brush border" while cell menbranes close to the basement membrane are extremely infolded and a lot of mitochondria are concentrated in those processes. The columnar cells contain cell organelles expected to be found is absorptive cell. The regenerative cells are aggregated into several groups between columnar cells on the basement membrane.

The noticeable changes in the histology of the midgut occur shortly after the last instar nymph has ceased feeding. As the regenerative cells activated and multiplied, and formed the new simple cuboidal epithelial cells. The old epithelium is separated from the basement membrane, pushed towered the lumen of the midgut and finally thrown off into gut lumen, where it is digested and absorbed by the new epithelial cells. At the last instar nymph stage before adult ecdysis, the epithelium is about 80um long and the nucleus move from the basal portion to the center of each cell.

#28

MORPHOLOGICAL DIVERSITY OF THE GENUS *EUOPS* (COLEOPTERA, CURCULIONOIDEA).

Yoshihisa SAWADA (Museum of Human and Nature, Hyogo 650, JAPAN)



#29

ECOLOGICAL SIGNIFICANCE OF THE FEEDING PARTS IN ARTHROPODS AND STUDY TECHNIQUES. Ujjal Singh Bhatti , Vijay V. Singh (Department of Zoology, I. P. Degree College (Meerut Uni) Bulandshahar (U.P.), 203001, India)

A careful examination of the skeleto-muscular and neural constituents of feeding appendages and or equipments often yield a great deal of information, as to the ecological significance of the organisms bearing them (Bhatti and Sharma, 1991). This very study has not as yet been extensively made (Joan & Frank, 1984); this is especially true for the Indian arthropod fauna. This study attempts to pin point the morpho-anatomical specifications of the feeding organs in micro- and macro-arthropods inhabiting in the aquatic as well as terrestrial ecosystems and belonging to all the major classes of phylum Arthropoda. Plumose setations and or flat grinding mandibles are associated with herbivorous species, whereas the carnivores are armed with apiny, widely spaced and carinate mandibles-in the micro-arthropod species.The study techniques involved: preparations of the permanent whole mounts, section cutting in T.S. and L.S. of animals or their exuviae or limbs. Manipulations of the limbs or animals is simplified in a viscous glycerol medium/polyviny lactophenol.

#30

CORRELATED STRUCTURE UNDERDEVELOP OF MALEGENITALIA IN TROPIDUCHIDAE(HOMOPTERA, FULGOROIDEA, TROPIDUCHIDAE). Si-zheng Wang, Ju Huang(Pomological Research Institute Shijiazhuang, Hebei Academy of Argiculture and Forestry Sciences, 5-7 street, 050061, Shijiazhuang, China)

In this paper we emphasize two structurals names: tectiform structure and tectiductus; and introduce the characters of underdevelop malegenitalia in the family Tropiduchidae, it is that the tectiform structure is small, the connective corps much be slim correspondly. And so we can measure the degree of secual maturity by the size of tectiform structure.

MORPHOLOGY RESEARCH ON NATURAL ENEMIES OF DRYOCOSMUS KURIPHILUS YASUMATSU. Jing-fang Huang, You-qing Luo (Beijing Forestry University)

With light microscope and scanning electron microscope, morphological characters of egg, mature larvae, pupa of main parasites (Torymus sinensis Kamijo, Torymus geranii(Walker), Eurytoma rosae Nees, Eurytoma setigera Mayr, Decatoma concinna (Boh.), Eupelmus urozonus Dalman, Ormyrus sp.) were first systematically studied and described. Results show that differences of morphological characters in egg, mature larvae, pupa are obvious. Main classification characters of mature larvae are position number and length of chaetae in epicranium and body surface; antenna; morpha of mandible; structure of body surface. Main classification characters of egg are colour, egg petiolule and its length; morpha of egg body. We think that classification on groups of Chalcidoidea with morphological character of mature larvae is feasible.

ON THE ULTRASTRUCTURE AND PATHOLOGY OF GRASSHOPPER MICROSPORIDIA. Li-ying Wang, Chun Cao (Department of Plant Protection, Beijing Agricultural University, Beijing 100094, China)

The morphology and development of a microsporidia, isolated from the dead body of oriental migratory locust Locusta migratoria manilensis (Meyen) in Hebei Province in 1989 was observed under light- and electron-microscope. It mainly infected the fatbody and salivary gland of the host. The meront was spherical containing 1, 2 or 4 nuclei with 6.4, 7.1 or 8.1 μm in size respectively. The tri- and hexa-nucleated meronts, 7.1 and 2.5-6 μm in size, were peculiar to this specimen. The sporont possessed 2 or 4 nuclei, the spore and aporoblast were all diplo-nuclear. There were many ribosomes, some vesicles and dense and smooth endoplasmic reticulum in the plasma of meront which were diplo-nuclear and closely arranged. According to the morphological characters such as apansporoblastic, uniform, and close diplo-nuclear arrangement during the whole life cycle, etc., this microsporidia must belong to Genus Nosema. The results of pathogenicity observation showed that the host mortality increased with the inoculated dosage, the 3rd instar nymph was more sensitive than the 4th instar nymph. The development duration of infected host was extend, its fertility was decreased, and its feeding amount 24 days after inoculation was 35-75% reduced.

A STUDY ON THE FEMALE REPRODUCTIVE SYSTEM OF ENCARSIA FORMOSA GAHAN. Qing Wang, Yu-hua Yan (Department of Plant Protection, Beijing Agricultural University, Beijing 100094, China)

The female reproductive system of Encarsia formosa Gahan consists a pair of ovaries, ovarioles, right and left oviduct, common oviduct, a single colleterial gland and spermatheca.

More than 3000 female individuals of E. formosa collected from the greenhouses in Beijing district were dissected. Each pair of ovaries has 12 ovarioles.

THE INNER ORGANS AND THE FINE STRUCTURE OF WAX GLANDS AND SPERMS OF PARACEROSTEGIA JAPONICUS (GREEN) Jucai Han, Huiping Liu, Fangte Tang (Department of Plant Protection, Shanxi Agtricultural University, Taigu, Shanxi 030801, China)

The present paper mainly studies morphology and fine structure of Paracerostegia japonicus (Green). The wax glands in female adults were classified to ten forms. The sperms of this scale insect were filamentous in motile bundles. Each bundle had about 16 sperms and was covered by membranous sheath. Anterior portion of the sperm was spiral, the middle portion was wider and the posterior portion gradually became slender. Under electronic microscope the sperms transected in their middle portion had a nuclear region and many microtubules arranged in a concentri pattern. Acrosome, centrioles and mitochondria were not found. In addition, this paper anatomied the inner organs of adult femals including nervous system, respiratory system, digestive and excretory systems.

LARVAL MORPHOLOGY OF CONOPOMORPHA LITCHIELLA BRADLEY. Zhen-wei Yao (Department of Plant Protection, Zhongkai Agrotechnical College, Guangzhou 510025, China)

In this paper the morphology of the sap-feeding and the tissue-feeding larval forms of Conopomorpha litchiella Bradley are described and illustrated in detail. The first two instars are sap-feeders which have very flattened bodies with blade-like mandibles and mine a long gallery in the epidermis of litchi leaves, and the 3rd to 6th instars are tissue-feeders which have cylindrical bodies with normal mandibles and bore into the principal vein or parenchyma. All two XD setae are present on the prothorax of last larva, and that is an exception in the genus Conopomorpha.

ANATOMY OF THE FEMALE REPRODUCTIVE SYSTEM OF SPHINGIDS. Fang-qiang Zheng, Zhao-hui Li, Dong-ling Song (Department of Plant Protection, Shandong Agricultural University, Taian, 271018, China)

Morphology of the female reproductive system of 13 species of Sphingids in Shandong is studied anatomically The female reproductive system consists of a pair of ovaries, each of which has four ovarioles (particularly, one ovary four ovarioles another five ovarioles in some individuals of Herse convolvuli (L.)), two lateral oviducts median oviduct, vagina, spermatheca and its gland, a pair of accessory glands, one bursa copulatrix and seminal duct. The accessory glands open into vagina at the middle part. The seminal duct connects bursa copulatrix at the base with the vagina at the apical part, opposite to the openning of ductus receptaculi. The spermatophore in bursa copulatrix is described, the shape of bursa copulatrix fit in with that of the spermatophore.

STUDIES ON THE MALE GENITALTA OF MELOIDAE FROM XINFIANG. Ren-xin Huang, Hong-guang Shao (Department of Biology, Xinjiang University, Urumqi 830046, China)

This paper deals with the studies on the male external genitalia, tergum IX and spiculum gastrale of 20 species of Meloidae from Xinjiang. Among these 20 species: 2 belonging to the genus Epicauta, 2 to the genus Lytta, 1 to the genus Meloe, 1 to the genus Cerocoma, 14 to the genus Mylapris. The results can be summarized as follows: 1. The main components of the male external genitalia are a tegmen and a median aedeagus, it is part to types vaginatus, but more primitive. 2. The form and structure of external genitalia have great differences between the genus and tribes. 3. The clear differences in subgenus and species not only reflected in the characteristics of the tegmen and aedeagus, but also reflected in the characteristics of the tergum IX and the spiculum gastrale which associated with genitalic musculature.

HOW CELLS ARE INFLUENCED BY THE HORMONAL MILIEU.
Lynn M. Riddiford, Department of Zoology, University of Washington, Seattle, WA 98195, USA.

Growth, molting, and metamorphosis of insects are coordinated by two primary hormones, ecdysone and juvenile hormone (JH). Whether a cell responds depends on the presence of hormone receptors. How it responds depends on the cascade of gene activation and inactivation elicited by the hormone and thus on the types of transcription factors present and/or induced in the cell as well as the form of the receptor present. Ecdysteroid receptors (EcR) are nuclear and present in larval epidermis at low levels during both the intermolt and the molt with 2-3 times higher levels appearing when the cells become pupally committed in response to low ecdysteroid in the absence of JH. By contrast, larval motor neurons have few EcR at any time during larval life, then show high levels at the time of their metamorphic commitment (JW Truman, personal communication). Later they then display different forms of the EcR depending on their fate (to be remodeled or to die). The levels and forms of EcR thus are regulated both by ecdysteroid and by JH in a tissue-specific manner. The presence of the nuclear 29kD JH receptor (JHR) in larval intermolt epidermis is dependent on JH both during the molt and during the intermolt. Then the JHR are lost at the time of pupal commitment due to ecdysteroid acting in the absence of JH. To initiate and coordinate a molt, ecdysteroid induces a number of specific transcription factors, many of which also have different forms that may be important in selection of the specific genes regulated. MHR3 is one such factor which appears very early in a tissue- and regional-specific pattern that is correlated with ecdysteroid sensitivity and likely the level of ecdysteroid receptor. Its role in regulation of specific intermolt and molt-related genes is under study.

HOW CELLS TALK TO ONE ANOTHER - INTERCELLULAR COMMUNICATION. Stanley Caveney, (Department of Zoology, University of Western Ontario, London, Canada N6A 5B7.)

Glutamate, in binding to different postsynaptic glutamate receptor/ion channel complexes (GluR) on skeletal muscle, acts both as an excitatory junctional- and an inhibitory nonjunctional-neurotransmitter in insects. Glutamate is also membrane-active on other insect tissues, such as the epidermis, which have electrogenic, Na^+-dependent, glutamate transporters (GluT) that, by removing glutamate (and aspartate) from the blood, aid in keeping glutamate below the micromolar synaptic threshold. Consequently, it is possible that (i) tissues such as the epidermis affect muscle GluR activity by modulating blood glutamate levels, and/or that (ii) neuromuscular activity influences the metabolic 'awareness' of other tissues by stimulating GluT activity. Whether interactions of this type exist between target (GluR-containing) tissues and non-target (GluT-containing) tissues remains to be shown. Nevertheless, submillimolar levels of extracellular glutamate induce metabolic stress in the epidermis *in vitro* and cause cell-to-cell communication via gap junctions to rise in this tissue. The importance of communication relating synaptic transmitter activity to metabolic activity elsewhere in tissues may explain in part why the neuromuscular synapse is directly exposed to the blood in insects.

INSECT MODELS FOR STUDIES OF STRESS AND ADAPTATION. Kenneth B. Storey (Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6 Canada)

Insects live under some of the most extreme environmental conditions on earth, surviving extremes of both high and low temperatures, desiccation, and low oxygen availability. They have adapted to endure these stresses with elegant biochemical mechanisms that include the regulation of cellular proteins and enzymes at transcriptional, translational, and post-translational levels. Insect species have perfected metabolic arrest strategies, mechanisms to preserve the structural and functional integrity of cells at deep subzero temperatures, and tolerances of extracellular freezing including adaptations that deal with the ischemia and free radical stresses that accompany freezing. The endurance of such extremes means that insect systems are excellent models for studying metabolic responses to stress for they demonstrate the adaptational limits of cellular metabolism and often illustrate strategies that can be applied in medical technology, such as organ cryopreservation. Recent advances in understanding cellular responses to stress and their regulation in insect systems will be discussed, focusing on the expression of shock proteins, the molecular actions of cryoprotectants, the mechanisms of detoxifying free radicals, and the reversible down regulation of metabolism via the coordinated actions of protein kinases and protein phosphatases on key regulatory enzymes and membrane transporter proteins.

Origin of Segmentation in Insect Embryos: Developmental and Evolutionary Consideration

INSECT BIOLOGISTS AND OUR UNDERSTANDING OF SEGMENTATION IN VERTEBRATES AND OTHER ANIMALS. John H. Postlethwait, (Institute of Molecular Biology, University of Oregon, Eugene, OR 97403 USA).

A spectacular revolution is underway in our understanding of the mechanisms of animal development. This explosive rate of advance is based on the ability of developmental biologists studying a wide variety of animals to identify genes that commit cells to specific developmental pathways at critical control points in early embryos. Many of these developmental switch genes encode nuclear proteins that bind DNA in a sequence-specific manner and regulate the transcription of specific sets of other genes. Such switch genes often encode homeobox domain proteins, zinc-finger proteins, or helix-loop-helix proteins. Embryologists investigating many species of invertebrates and vertebrates are able to identify those genes because of their molecular similarity to genes that regulate development in the fly *Drosophila melanogaster*. The Drosophila genes were initially identified because they give rise to mutant phenotypes with switched segment identity or polarity -- for example, legs replace antennae, or each segment has two posterior halves, or the embryo has no cells with a ventral fate. The truly astounding finding is that clusters of structurally similar genes appear in the same genetic order and a similar pattern of developmental expression in flies, beetles, and moths, and in mice and nematode worms as well! The purpose of this symposium is to explore the genetic, evolutionary, and developmental aspects of these segment identity and segment polarity genes in three orders of insects, and speculate on their origin and significance for the understanding of animal development in general.

EVOLUTION OF DROSOPHILA SEGMENTATION GENES. Nipam H. Patel (Carnegie Institution, Baltimore, MD 21210 USA), Eldon E. Ball (Research School of Biological Sciences, Canberra, ACT 2601 Australia), Corey S. Goodman (Dept. of Mol. and Cell Biology, U.C. Berkeley, 94720 USA)

Localized maternal cues and the sequential activation of zygotic gap, pair-rule, and segment polarity genes rapidly subdivide the *Drosophila* blastoderm embryo into a series of repeated units, generating a precise representation of the final larval body plan. Past embryological studies, however, suggest that this mode of development might not be shared by all insect embryos. We are examining the problem at the molecular level by analysing the expression patterns of grasshopper (*Schistocerca americana*) homologs of *Drosophila* segmentation and homeotic genes. Our studies on the grasshopper homologs of *Antennapedia, engrailed,* and *even-skipped* support the ideas of the conserveed germband stage, but also illustrate that the mechanisms guiding development to this point may differ between *Drosophila* and other insects.

COMPARATIVE EXPRESSION ANALYSIS OF EARLY SEGMENTATION GENES IN INSECTS. Diethard Tautz, Ralf Sommer, Monika Retzlaff (Zoologisches Institut der Universität München, Luisenstr. 14, 8000 München 2, Germany).

Most of the genes involved in early pattern formation in *Drosophila* are known and have been analysed in molecular detail. This forms the basis for a comparative analysis of the expression of these genes in other insects. Using PCR, we have cloned homologues of the gap genes *hunchback* and *Krüppel*, of the pairrule gene *hairy* and of the dorso-ventral genes *snail* and *twist*. The expression pattern of these genes was mainly analysed in the flour beetle *Tribolium castaneum*, an insect with a short germ band type development. It appears that all these genes may have a similar function as in *Drosophila*, inspite of the different mode of development in the beetle. This is in particular true for the pairrule gene *hairy*, which forms a number of stripes at early blastoderm stage, but also during the elongation of the germband. This raises a number of questions concerning the regulation of these genes in a cellularized embryo as opposed to the syncytial blastoderm situation found in *Drosophila*.

ON INSECT DEVELOPMENT BIOLOGY. Thomas C. Kaufman (Howard Hughes Medical Institute, Department of Biology, Indiana University, Bloomington, Indiana 47405)

One goal of developmental biology is to obtain an understanding of the role of the genetic constitution of an organism in th regulation of its ontogenic program. The organism we have chosen is the fruit fly *Drosophila melanogaster* and the genetic system is a set of homeotic genes that have been demonstrated to play a crucial role in th development of this insect. Specifically these homeotic lesions cause a transformation of one portion of the animal's anatomy into an identity normally found in another region of the body. Thus mutations at the *Antennapedia* locus cause a transformation of the antennae of the adult fly into a leg while lesions in the *proboscipedia* gene result in the development of legs in place of the mouthparts of the adult. Both of these genes are members of a cluster of five homeotic genes called the Antennapedia Complex (ANT-C), a tightly linked grouping found in a restricted domain at the base of the right arm of the third chromosome. --The aggregate results of genetic, developmental and molecular analyses of the ANT-C has revealed that the role of the resident loci is best viewed as a series of switches which make either/or decisions of cellular fate during development. Further, DNA sequence analysis of the homeotic loci has revealed that the proteins encoded by these genes contain a motif that confers DNA-binding activity to these polypeptides. Thus it appears that the switch activity of the genes is reflected in their functioning as transcriptional regulators which target specific "downstream" genes, serving to either turn these targets on or off. It is through this activity that the homeotics select alternate developmental fates. What is not clear is how each homeotic gene is restricted to its own unique pattern of expression. --In order to address this question we have concentrated our efforts on three of the resident members of the ANT-C: *Sex combs reduced* (*Scr*), *proboscipedia* (*pb*) and *labial* (*lab*). *Scr* is the only homeotic expressed at the juncture between the head and trunk and there were indications that the regulation of genes expressed in these two domains is different. Additionally our genetic analysis had shown that the sizes of the *pb* and *lab* loci is small. This meant that a complete dissection of the regualtory elements of each locus and the reconstruction of the necessary components *in vitro* was feasible for these two genes. Our current understanding of the regulation of these three loci is summarized in this report.

Genes Involved in Bombyx Body Plan
Yoshiaki Suzuki, Kohji Ueno, Toshifumi Nagata, and Kazuhito Amanai National Institute for Basic Biology, Okazaki 444, Japan

When the Bombyx body plan is compared with the Drosophila, some common features are shared but unique features are also evident. To study this problem we have begun analyzing the natures of the genes that are presumed to play important roles in development.

We have cloned and identified Bombyx homologs of Antp, Scr, Ubx, abd-A, Abd-B, en, in, cad, Cf1-a, and Wnt-1. Using these clones as probes we have analyzed the natures of homeotic mutants in the E complex and the Nc locus which are mapped about 1.4 cM apart on the sixth chromosome. We report here that the E complex accommodates Bombyx Ubx (Bm Ubx), Bm abd-A, and Bm Abd-B constructing Bombyx counterpart of the Drosophila BX-C. The Bm Ubx and Bm abd-A are deleted in the E^{N} chromosome, and the Bm abd-A is deleted in the E^{Ca} chromosome. In situ hybridization in the wild type embryos revealed the uniqueness of the Bm Ubx expression pattern. We report also that the Bm Antp is in the Nc locus and the Bm Scr is within 100kb from it. Thus, the Nc locus is a part of Bombyx counterpart of the Drosophila ANT-C.

THE HOMEOTIC COMPLEX OF THE RED FLOUR BEETLE. Robin E. Denell (Division of Biology, Kansas State University, Manhattan, KS 66506 USA) and Richard W. Beeman (USDA, ARS, U.S. Grain Marketing Research Laboratory, Manhattan, KS 66502 USA)

Studies of the genetic mechanisms controlling developmental commitments during embryogenesis are of fundamental biological significance. The powerful methodological approaches possible with Drosophila have shown that two clusters of "homeotic" genes encode transcription factors which function to establish developmental fate for much of the embryo. In many ways the development of the higher Diptera is quite advanced, and it is important to examine which features of Drosophila homeotic gene function are primitive or derived. Our recent studies with *Tribolium castaneum* show that this insect offers the possibility of integrated genetic, developmental and molecular studies with a resolution similar to that possible with Drosophila. Tribolium has a single Homeotic complex equivalent to the two Drosophila complexes in juxtaposition. We have molecularly cloned portions of almost all of the included homeotic genes, and have induced mutations in many of them. Evidence to date supports the hypothesis that homeotic gene function in the anterior portion of the Drosophila embryo reflects in several ways the advanced development of that insect, and the domain of the *abdominal-A* homolog shows significant differences as well. Nevertheless, as in Drosophila, this Tribolium *abdominal-A* gene does display parasegmental expression.

Hormonal Regulation of Reproductive Behavior in Orthopteran Insects

Horseman,G.[1],Hartmann, R.[2], Virant-Doberlet,M.[1], Huber,F.[1], Loher,W.[3]
1. Max-Planck-Inst. Behavioral Physiology, Seewiesen, FRG;2. Biol. Inst.I, U.Freiburg, FRG;3. Dept. Entomology, U. California, Berkeley, U.S.A.

In Gomphocerus rufus and Locusta migratoria, the Juvenile Hormone (JH)-producing corpora allata (CA) are innervated by neurons with somata in the pars lateralis (PL) of the protocerebrum. One type (13 cells) innervates only the ipsilateral CA via the NCC_2, the corpora cardiaca and the NCA_1, while 4 cells with bifurcated axons innervate both CA [1]. In a preparation of L. migratoria, which allowed hourly radiochemicalmeasurements of JH biosynthesis from one CA while stimulating the contralateral NCA_1 of the other CA over a period of 9 hours, JH-production rose progressively. Transection of the ipsilateral NCC_2 led also to an increase, whereas stimulation of that nerve caused a continuous decline of JH synthesis. Thus bilaterally innervating cells are possibly excitatory, and the ipsilateral cells inhibitory in nature.- Allatectomy of G. rufus females suppresses sexual behavior, whereas normal adults show an increasing sequence of behavior patterns such as passive/active copulatory readiness, courtship and defensive behavior [2]. But neither the rate of JH-synthesis nor the JH-titer of the hemolymph correlated as expected with these behavioral expressions. Rather, CA-activity changed after mating or oviposition. Females kept virgin for 4 weeks showed a fourfold increase in JH-production 12 h after insemination, and JH-synthesis rose in females without substrate for 4 weeks by a factor of 2.5 within 10 h after oviposition. It is assumed that signals from the sperm-filled spermatheca and depleted ovary stimulate the CA into higher JH-production via the brain.

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HORMONE TITER REGULATION IN REPRODUCTIVE ADULTS AND EMBRYOS OF CRICKETS, Gryllus bimaculatus. Klaus H. Hoffmann (Allgemeine Zoologie, Universität Ulm, Albert-Einstein-Allee 11, D-7900 Ulm, FRG)

Reproduction results in a succession of interdependent steps which take place at various stages of the insect's biological cycle. Its regulation involves numerous sensory receptors, nerve transmission, and the integration in the brain, which regulates the synthesis of the two groups of insect hormones, the juvenile hormones and the ecdysteroids, and produces its own neurohormones. In the Mediterranean field cricket, Gryllus bimaculatus, ovarian growth and oviposition rate can be modified by experimental manipulation of haemolymph hormone titers. In general, hormone titers are determined by the rate of hormone synthesis and secretion, but also by the rates of metabolism and excretion. In adult crickets, ecdysone is produced and released by the follicle cells of the ovary as well as by the abdominal integument. During adult life cycle, both ecdysteroid sources undergo a specific sequence of changes in synthetic capacity. The changes closely correlate to the activity of the ecdysone 20-monooxygenase which catalyses the hydroxylation of ecdysone to 20-hydroxyecdysone. Both sites of ecdysteroid synthesis show a distinct sensitivity to various ecdysteroid agonists and antagonists. The onset of juvenile hormone (JH) III synthesis by the corpora allata of adult females correlates with the appearance of vitellogenins in the blood. In both sexes, fluctuations in JH III synthesis are related to fluctuations in the activity of allatostatic and allatotropic peptides from the brain/subesophageal ganglion. The primary rate of JH III metabolism in cricket haemolymph is ester hydrolysis. With respect to these results it is probable that the neuroendocrine control of reproduction is a major target of selective forces which are responsible for adapting insects to their environment.

Catecholamines in the reproduction of insects

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The control of oocyte growth and ovulation in insects (Periplaneta americana) is based on an axis of cerebro-retrocerebral-gonadal agents, which is characterized by an interaction between the aminergic and peptigergic systems on the one hand (Hentschel, E., Zool. Jb. Physiol.76 (1972), 356) and an apparently steroid-hormonal feedback mechanism between ovary and brain-retrocerebral complex on the other (cp.Hentschel, Ad. Physiol. Sci. 22 (1980/81), 205).
Dopamine receptor blockade by means of pimozide and haloperidol is followed by an inhibition of oocyte growth and decreased formation of ootheca.
Moreover the cerebral amine peptide interaction is influenced in a cholinergic way in insects as well as in other animals.
During the ovulation cycle of Periplaneta americana, an AChE cycle could be detected.

THE ROLE OF JUVENILE HORMONE AND ECDYSONE IN MOSQUITO REPRODUCTION. Dov Borovsky (University of Florida - IFAS, FMEL, 200 9th Street S.E., Vero Beach, FL 32962 USA), D. A. Carlson (USDA, ARS, Gainesville, FL 32604 USA).

Yolk protein synthesis, vitellogenin, in the mosquito *Aedes aegypti* is controlled by two classes of hormones: a. peptide hormones (i.e. ecdysotropic hormones, EDNH) and b. non-peptide hormones (i.e. juvenile hormone (JH) and ecdysone). Borovsky et. al. 1985, reported that both JH and ecdysone are needed for stimulating yolk protein biosynthesis. We have followed the biosynthesis of JH III *in vivo* and *in vitro* by the corpora allata (CA) of sugar-fed and blood-fed female *A. aegypti* and found that JH III is synthesized before and after the blood meal. High levels of JH III biosynthesis continued for 2-5 hr after the blood meal indicating that the hormone may be used to derepress the vitellogenin gene. The biosynthesis of JH III declined rapidly 5 hr after the blood meal reached a low level at 12 hr, and then increased again. The relationship between the biosynthesis of JH III by the CA and ecdysone by the ovary will be discussed.

ECDYSTEROID TITRE AND OVARIAN DEVELOPMENT IN TWO BUGS WITH IMAGINAL DIAPAUSE. N.I.Kozhanova (Research Institute for Plant Protection, 18866 St. Petersburg, Russia), F.Sehnal (Entomological Institute CSAV, 370 05 Ceske Budejovice, Czechoslovakia)

Segregation and enlargement of ovarioles as well as the formation of functional oviducts in the last instar larvae of bugs are induced by the molt-inducing surge of ecdysteroids, and are not linked to a certain stage of oogenesis. Oocytes in the zygotene stage occur in *Pyrrhocoris apterus* and *Eurygaster integriceps* within 1-2 days of the last larval instar, but only in *P. apterus* they initiate cytoplasmic growth before imaginal ecdysis: in the larvae grown under long photophase (i.e. destined to give reproducing adults), the enlargement of oocytes coincides with the peak of ecdysteroid titre, whereas in those reared under short photophase (i.e programmed to render diapausing adults), with the ecdysteroid increase preceding the peak. Previtellogenesis begins under both regimes concurrently with the imaginal ecdysis. In the reproducing adults it is immediately followed by vitellogenesis, while in the diapausing females it continues slowly until maximal previtellogenic size; then the oocyte degenerates and is resorbed. In *E. integriceps*, which has an obligatory imaginal diapause, oocytes remain in the zygotene stage until about 5 days after emergence; they initiate cytoplasmic growth on day 8 and previtellogenesis is completed only at the end of diapause (no oocytes degenerate). Obviously, the rate and hormonal control of gonadal differentiation in the anticipation of diapause are species specific.

MYOTROPIC PEPTIDES ISOLATED FROM THE ACCESSORY GLANDS OF MALE *LOCUSTA MIGRATORIA*. A. De Loof, L. Paemen, L. Schoofs. University of Leuven, Zoological Institute, Naamsestraat, 59, 3000 Leuven, Belgium.

The male accessory glands of *Locusta migratoria* consist of 2 symmetrical masses of 4 different intertwined tubule types: the hyaline, white and opalescent glands and a seminal vesicle. Using the *Leucophaea*-hindgut and the *Locusta*-oviduct bioassay, 3 myotropic peptides were isolated and identified:

Proctolin: Arg-Tyr-Leu-Pro-Trh-COOH
Lom-AG-MT 1: Gly-Phe-Lys-Asn-Val-Ala-Leu-Ser-Thr-Ala-Arg-Gly-Phe-CONH2
Lom-AG-MT 2: Ala-His-Arg-Phe-Ala-Ala-Glu-Asp-Phe-Gly-Ala-Leu-Asp-Thr-Ala-COOH

As shown by immunocytochemical methods, the distribution of both Lom-AG's gland type specific and the reaction is faint. Stronger reaction was found in small fibers innervating the muscle layer surrounding individual tubules and the ejaculatory duct, in different parts of the brain, in the thoracic and abdominal ganglia. No colocalisation was observed. Upon perifusion of the glands both Lom-AG-MT 1 and 2 cause a depolariation, while proctolin hyperpolarises.

LARVAL-ADULT OVIDUCT TRANSFORMATION IN ONCOPELTUS FASCIATUS: HORMONAL REGULATION AND CYTOLOGICAL DIFFERENTIATION. August Dorn, Petra Berger-Twelbeck (Institute of Zoology, University of Mainz, Saarstr. 21, D-6500 Mainz, Germany)

The lateral oviducts of O. fasciatus undergo a drastic larval-adult transformation during the last larval instar. Between day 3 and day 5, the long and thin larval oviducts shorten and become very wide. The transformation is ecdysteroid-dependent in a dose-related manner which was shown by premature ecdysteroid treatment and by postponement and partial suppression of the endogenous ecdysteroid peak with azadirachtin. Transformation only takes place in the absence of corpus allatum activity. This was demonstrated by application of JH and chemical allatectomy with precocene in young larvae. The morphological transformation is accompanied by dramatic cytological changes. The very long fusiform epithelial cells rearrange in a hitherto undescribed manner in morphogenetic processes. Whereas the cells of the cranial part of the oviduct commences with a strong secretory activity, the cells of the caudal part form a bizarre pattern of cell projections which deposit a cuticle, thus creating an intricate luminal surface structure. The transduction of the hormonal signal during transformation on the cellular level is presently being investigated.

PUTATIVE REGULATION REGION OF VITELLOGENIN GENE A1 OF MOSQUITO *Aedes aegypti*. Zhaoxi Ke, Henry H. Hagedorn, (Department of Entomology,University of Arizona, Tucson, AZ 85721, USA), and Patricia Romans, (Department of Zoology, University of Toronto, Toronto, Ontario M 5S 1A1, Canada)

Vitellogenin genes of the mosquito *Aedes aegypti* are only expressed in the fat body and are induced by the steroid hormone, 20-hydroxyecdysone. A vitellogenin gene A1 has been previously cloned. The upstream region and part of the coding region have been sequenced. The consensus sequences for steroid hormone responsive elements of several steroid-regulating genes were found in -682 to -720 bp upstream from the transcriptional start site of gene A1. These consensus sequences are 71% to 78% identical to the mosquito sequence. The N-terminal sequence of the vitellogenin small subunit (67 kd) is Tyr-Gln-Tyr-Gln-Asn-Ser-Phe-Lys-Gly. This demonstrates that the vitellogenin gene A1 is first transcribed for the small subunit and the large subunit may be transcribed later. There is a 70 bp intron within the signal sequence. The signal sequence encodes a 16 amino acid signal peptide which has a 69% homology with that of *Anopheles gambiae* and a 50% homology with that of *Locusta migratoria*. A construct of this upstream region with a beta-galactosidase gene coding region has been completed and is being transfected into cultured mosquito cells to define nucleotide regions that confer hormonal responsiveness.

STRUCTURE OF THE EGG-SPECIFIC PROTEIN GENE AND ITS EXPRESSOIN IN OOGENESIS OF THE SILKWORM, *BOMBYX MORI*. Okitsugu Yamashita (School of Agriculture , Nagoya Univ.) and Y. Sato (Radioisotope Research Center, Nagoya University, Chikusa, Nagoya 464-01, Japan)

In the silkworm, *Bombyx mori*, ovarian follicle cells largely contribute to vitellogenesis by synthesizing a yolk protein, egg-specific protein (ESP). Oogenesis takes place with the accumulation of ESP even at the no vitellin accumulation, indicating ESP plays an important role than vitellogenin.

We have analyzed structure of the ESP gene and its expression during oogenesis. The ESP gene is a typical polymerase II gene, except for lacking introns. Some sequences in 5'-upstream region were proposed as the candidates for regulatory elements by homology search: short sequences homologous to the ecdysteroid response elements of the heat shock protein genes and the glue protein genes, *cis*-acting elements of chorion genes, and a protein factor binding site of the fibroin gene. The ESP gene was highly similar to the yeast lipase gene in their flanking region. There was a 35 % similarity between ESP and lipases of human and rat. Thus, ESP is assumed to be evoluted from a common ancestor of lipase family members.

Northern analysis showed expression of the ESP gene is closely correlated to the developmental stages. ESPmRNA was accumulated in vitellogenic stages, which was followed by the chorion mRNA accumulation. The transcription of the ESP gene never stimulated in isolated pupal abdomens in which ovarian growth ceased. The administration of 20-hydroxyecdysone into the isolate pupal abdomens stimulated the transcription of the ESP gene and resumed oogenesis.

THE CELL BIOLOGY OF INSECT (MOSQUITO) VITELLOGENESIS. **A.S.Raikhel, T.S.Dhadialla, W.L.Cho, A.R.Hays, K.W.Deitsch, J.S.Chen** (Program in Genetics and Department of Entomology, Michigan State University, East Lansing, Michigan 48824, U.S.A.)

Studies at the cellular, biochemical and molecular level have led to realization of the complexity of events associated with the synthesis of yolk protein precursors in the mosquito fat body and their uptake by developing oocytes. The biosynthesis of vitellogenin by the fat body involves several steps of co- and posttranslational modifications of the vitellogenin precursor. In addition to vitellogenin, the fat body of vitellogenic mosquitoes produces a pro-enzyme of carboxypeptidase and two 40-kDa proteins. These three proteins are deposited in yolk bodies of developing oocytes. Vitellogenic carboxypeptidase is activated during embryonic development. Each synthetic cycle of yolk protein precursors involves proliferation and degradation of the fat body biosynthetic machinery. The cDNA coding for a lysosomal enzyme was cloned in order to study these events at the molecular level. Properties of endocytosis of vitellogenin by developing oocytes and vitellogenin binding to ovarian membranes have been investigated. Finally, the vitellogenin receptor, solubilized from ovarian membranes, has been visualized and characterized.

EFFECTS OF VITELLOGENIN ON SECONDARY YOLK PROTEIN UPTAKE BY MOTH FOLLICLES. William H. Telfer, Peter C. Kulakosky (Department of Biology, University of Pennsylvania, Philadelphia, PA 19104-6018, USA) and M. L. Pan (Department of Zoology, University of Tennessee, Knoxville, TN 37996-0810, USA). Eggs of the North American silkmoth, Hyalophora cecropia, contain in their yolk an average of 900 pmoles vitellogenin (Vg), 650 pmoles microvitellogenin (Mvg), 300 pmoles lipophorin (Lp), and only 2 pmoles each of two abundant hemolymph storage proteins. Kinetic analyses have shown that selective uptake of Vg, Mvg, and Lp is due to a saturable mechanism. Vg and Lp compete with each other, while Mvg appears to be concentrated separately; two receptors may therefore be entailed. Vg is unique in being able to accelerate the uptake of fluid phase markers and other hemolymph proteins by up to 100%. Ovaries transplanted to males, which have only trace levels of Vg in their hemolymph, produced eggs weighing 60% of those produced in females, and containing 80% as much Lp; it appears that absence of competition with Vg was offset by the absence of Vg's endocytosis-accelerating ability. Lp was delipidated by male-grown follicles to a very high density form, as it is in females.

RECEPTORS FOR INSECT VITELLOGENINS. Hans-Jörg Ferenz (Insect Physiology Group, University of Oldenburg, D-2900 Oldenburg, Federal Republic of Germany)

In insects large amounts of yolk proteins of extraovarian origin are accumulated by developing oocytes during vitellogenesis. The yolk protein precursors, the vitellogenins (VTG), are selectively incorporated by receptor-mediated endocytosis. VTG receptors have been identified and partly characterized by binding studies and ligand blotting in ovarian membranes of several insect species. In *Locusta migratora* the VTG receptor protein has been isolated and purified by immunaffinity chromatography. It is an acidic 180 kDa glycoprotein (non-reducing conditions) with large amounts of *N*- and *O*-linked oligosaccharides among them neuraminic acid which has been found to be essential for receptor function. With a polyclonal antibody the locust VTG receptor was localized in oocyte membranes and in endocytotic vesicles. Chemical modification of the positively charged lysyl and arginyl residues of locust VTG resulted in the loss of binding to the locust VTG receptor. It is concluded that they are involved in the expression of a recognition site which interacts with the binding domain of the receptor. Homologies among several insect, invertebrate and vertebrate VTG receptors and VTG recognition by such membrane receptors have been found. These results indicate that binding domains for VTG and other key structural elements have been conserved in VTG receptors as well as in VTGs from oviparous species.

FATE OF YOLK PROTEINS DURING EMBRYOGENESIS. Susumu Y. Takahashi (Dep. of Biol., Fac. of Liberal Arts, Yamaguchi Univ., Yamaguchi, Japan)

Arthropod eggs accumulate yolk proteins in large storage organells called yolk granules. Major function of the proteins are considered to be amino acid sources for developing embryos. In cases of insect yolk protein degradation, the involvement of proteinases has been suggested in several systems, whereas very few proteinase have been purified. Furthermore the regulatory mechanism of the proteinases are still unknown. Three kinds of yolk proteins, vitellin, egg-specific protein and 30 KDa-proteins, are found in the bombyx eggs and well characterized and these proteins are utilized differently during the embryogernesis, indicating that specific regulatory mechanism of each yolk protein might exist. Recently, several proteinases have been isolated and characterized from Bombyx eggs. In this review, we will first describe the degradation of yolk proteins by the recent results obtained from silkmoth, brine shrimp, African soft tick, as well as from other insects, and then the regulatory mechanism and the properties of the proteinases will be explained. Finally, we will discuss how the specific kinds of proteinase can selectively hydrolyze the yolk proteins, in which the special attention will be given to the regulation and initiation of vitellin degradation during the early embryogenesis.

CIRCADIAN MECHANISM REGULATING RHYTHMIC RELEASE OF SPERM FROM MOTH TESTIS. Jaga M. Giebultowicz[1,2],Janet E. Joy[3] and Ashok K. Raina[1]. [1]INHL,USDA, Beltsville, Md. [2]Dept. Zoology, University of Maryland, College Park, Md. [3]NIMH Neurosciences Center, St. Elisabeths Hospital, Washington D.C.

In the gypsy moth, *Lymantria dispar*, and in other moths, the release of sperm bundles from testis into the vas deferens is precisely timed within each 24 h period. Declining levels of 20-hydroxyecdysone allow initiation of rhythmic sperm release at 4-5 days before eclosion. The circadian pacemaker which controls rhythmic sperm release in gypsy moth is located in the reproductive system and operates *in vitro* without any neural or endocrine input.

While the release of sperm is synchronous in males kept under LD 16:8, in males kept since pupation under constant darkness (DD) and temperature, the release of sperm was asynchronous among individuals. Cycles of LD 16:8, a single 8 h light pulse, or a single 8 h pulse of 4°C temperature increase failed to induce rhythmic sperm release in DD pupae when applied during the first 5 days after pupation; however, when applied after day 6, each of these signals elicited rhythmic sperm release. Thus, the pacemaker controlling rhythmic sperm release appears to develop during the differentiation of the adult reproductive system and begins to operate two days prior to first sperm release. With the use of two-dimentional gel electrophoresis, protein changes associated with the development of the circadian system were analysed in (1)cellular basilar membrane, through which sperm bundles periodically leave the testis, and (2) in vas deferens in which the sperm remain overnight. A limited number of proteins increase or decrease during different stages of development of the circadian system regulating sperm release.

ON THE VITELLOGENESIS AND ITS HORMONAL CONTROL OF HOUSEFLY MUSCA DOMESTICA. He Gong, Qian-jun Li (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Vitellogenin(Vg) titer and total protein in the fat body, hemolymph and ovaries of the female adults were studied. The results showed that a close relationship between these tissues was demonstated. Generally, Vg appeared in hemolymph at 30 hr.after emergence and reached a peak at 48 hr after emergence. The fat body Vg contents during vitellogenesis showed the same pattern as hemolymph Vg. The Vg deposition in ovaries began at 30 hr. after emergence, increased sharply in vitellogenic stage and reached a peak before oviposition. Synthesis of Vg and its hormonal control were investigated in the fat body from adult female at different stages of development by incubation in vitro with ^{3}H-Leucine. The results showed that the Vg synthesis increased sharply at 12 hr. after emergence and reached a maximum at 48 hr., then the rate of Vg synthesis decreased sharply at 60 hr.after emergence and kept in low level in postvitellogenic flies. Hormonal treatment showed that Vg synthesis was stimulated by JH III at previtellogenic and postvitellogenic stage. Tje Vg synthesis was stimulated by 20-hydroxyecdysone to a greater extent at vitellogenic stage. While treated with both JH III and 20-hydroxyecdysone, the Vg synthesis was stimulated at previtellogenic or vitellogenic stage, but no cordinative function at postvitellogenic stage. The hormonal regulation of vitellogenesis in the housefly was discussed.

THE USE OF MALE-INCUBATED OVARIES FOR STUDYING OOGENESIS IN THE GYPSY MOTH, *LYMANTRIA DISPAR*.
Michael Ma and Joanne Ballarino (Department of Entomology, University of Maryland, College Park, MD 20742, U.S.A.)

The gypsy moth female initiates vitellogenin synthesis and production during the last larval instar. During the same period, pre-vitellogenic follicles are detached from the germarium. Uptake of vitellogenin from the hemolymph started on the second day of the pupal stage and continued the maturation process up to 10 days. We were interested in the development of ovary in a male hemolymph environment that was devoid of vitellogenin. Female gonads were transferred from fourth instar females to a fourth instar males. The implanted ovaries were retreived at different incubation times for morphological and ultrastructural comparisons. While the male grown ovaries were found to be similar to the normal ovaries, the yolk protein content and developmental rates were different. The results revealed insights to the control mechanisms of lepidopteran oogenesis.

ENDOCRINE CONTROL OF OVARIAN DEVELOPMENT IN MOSQUITOES. Dov Borovsky (University of Florida-IFAS, FMEL, 200 9th Street S.E., Vero Beach, FL 32962, USA), D. A. Carlson (USDA, ARS, Gainesville, FL 32604, USA), M. Ma, Q. Song (Department of Entomology, University of Maryland, College Park, MD 20742, USA).

Mosquito-ovary is a unique organ that controls its growth and development by hormonal regulation. One of the hormones that has been recently isolated, sequenced and synthesized, Borovsky et. al. 1990, is a decapeptide that directly modulates trypsin biosynthesis in the mosquito gut, and indirectly regulates egg development, and thus, was named Trypsin Modulating Oostatic Factor (TMOF). The hormone is synthesized in the follicular epithelium of the ovary and is actively secreted by the ovary between 24-48 h after the blood meal modulating trypsin biosynthesis in the epithelial cells of the midgut. We have followed hormonal dose response, metabolism, biosynthesis and secretion using RIA, ELISA, cytoimmunochemistry and tissue culture incubations combined with HPLC. The biological role of the hormone and its significance will be discussed.

REPRODUCTIVE DIAPAUSE IN MALE INSECTS; ENVIRONMENTAL EFFECTS, ENDOCRINE REGULATION AND COADAPTATION TO FEMALE REPRODUCTIVE STRATEGIES. M.P. Pener (Department of Zoology, The Hebrew University, Jerusalem 91904, Israel)

Reproductive diapause in male insects, defined as a reversible state of inability of the male to inseminate receptive females, is reviewed. When females have a reproductive diapause, there are several patterns of coadaptation between male and female reproductive strategies. (A) In some insects females are receptive in the early part of their diapause, mating occurs during this period and there is no diapause in the male which dies shortly after copulation. The female stores the sperms to fertilize the eggs that develop after termination of her diapause. (B) In some species, females are receptive during diapause; though oocyte development is arrested, copulation occurs and the stored sperms fertilize the eggs when the female's diapause ends. Female diapause may or may not be accompanied by male reproductive diapause, or reproductive diapause may exist only in a portion of the males. If there is a reproductive diapause in the male, it is controlled by the same endocrine mechanism, the corpora allata (CA) and the juvenile hormone (JH), as in the females. (C) In many species females are refractory during their diapause and in these cases the males also exhibit reproductive diapause, which is usually controlled by similar environmental cues (photoperiod, temperature) and by the same mechanism (especially CA/JH) as female diapause. Nevertheless, male diapause is less intense; the environmental cues leading to its termination are less complex and/or less extreme, so male diapause terminates before that of the females. Presumably, a male diapause is under two antagonistic selection pressures; a male should not waste energy by courting diapausing refractory females, but he should be ready to copulate as soon as the females become receptive.

BENZYL-1,3-BENZODIOXOLE DERIVATIVES AND THEIR EFFECTS ON THE REPRODUCTIVE PHYSIOLOGY OF INSECTS. Franklin Chang (Department of Entomology, University of Hawaii at Manoa, Honolulu, Hawaii 96822 U.S.A.)

Multiple biological functions have been attributed to methylenedioxy derivatives of benzyl-1,3-benzodioxole (BBDs) and related benzylphenols. These include inhibition of cytochrome P-450 monooxygenase activity and tubulin polymerization and mitosis in mammals, and juvenile hormone (JH) activity in insects. BBDs have been shown to affect insect reproduction by topical or oral administration or by contact with BBD-impregnated soil. Our results with tephritid fruit flies treated with BBDs suggested a mode of action based on interference with JH function. Further results from competitive protein binding and radiochemical assays coupled with electron microscopical analyses, suggested that the multiple biological effects of BBDs seen in insects may be due to inhibition of microtubule assembly (by BBDs) in specific insect tissues.

ENVIRONMENTAL, PHYSIOLOGICAL AND DEVELOPMENTAL REGULATION OF THE CORPORA ALLATA IN COCKROACHES.

Ann-Shyn Chiang and Coby Schal (Department of Entomology, Cook College, Rutgers University, New Brunswick, NJ 08903, U.S.A.)

Juvenile hormone (JH), synthesized by the corpora allata (CA) is known to play a central role in the regulation of many reproductive events in cockroaches. The cycle of JH biosynthesis during the gonotrophic cycle is regulated by both environmental cues and feedbacks from target tissues acting either directly on the CA or indirectly through the brain. We examined responses of the CA to various external (e.g., grouping, food and mating) and internal stimuli (e.g., brain and ovarian factors) by monitoring JH biosynthetic rates *in vitro* and morphometric changes in the CA in the oviparous cockroaches *Blattella germanica* and *Supella longipalpa* and in the viviparous *Diploptera punctata*. These three cockroach species exhibit different patterns of oocyte development in precise correlation with patterns of JH biosynthesis. Although many factors may influence JH biosynthesis in species-specific manners, the underlying mechanisms that regulate CA activity are similar. Our data show that both stimulatory and inhibitory factors act by inducing developmental changes in the CA. During ovarian cycles in all three cockroaches, CA cells undergo synchronous cyclic hypertrophy in relation to elevated glandular activity while the number of CA cells remains constant. Thus, environmental and physiological stimuli act jointly on CA development resulting in cyclic production of JH in cockroaches.

PHEROMONOTROPIC STIMULATION OF MOTH PHEROMONE GLAND CULTURES *IN VITRO*. Ada Rafaeli (Department of Zoology, George S. Wise Faculty of Sciences, Tel Aviv University, Tel-Aviv 69978.
The direct neurohormonal control of pheromone biosynthesis by pheromone biosynthesis activating neuropeptide (Hez-PBAN) was demonstrated in *Helicoverpa (Heliothis) spp.* using pheromone gland cultures *in vitro*. Pheromone gland activation involved the *de novo* production of the main pheromone component (Z)-11-hexadecenal as revealed by radio-TLC, radio-HPLC and radio-GC. Activation was found to be a specific response attributed to pheromone gland cultures alone. Specificity of pheromonotropic activation was demonstrated to be limited to nervous tissue extracts. A sensitive and specific radioimmunoassay (RIA) was developed using [^{3}H]-PBAN and the spatial and temporal distribution of PBAN-immunoreactivity was studied. PBAN-immunoreactivity in brain complexes was found throughout the photoperiod and in all ages. From the distribution of PBAN-immunoreactivity it appears that PBAN release is affected by photoperiod. Pheromone gland cultures were found to be competent to pheromone production irrespective of age and photoperiod. Therefore the neuroendocrine control of pheromone production operates at the level of neuropeptide synthesis and/or release and not at the level of the target tissue itself. The involvement of c-AMP as the second messenger system was demonstrated. Brain extracts and PBAN were shown to stimulate dose and time-dependent changes in intracellular c-AMP levels. The role of c-AMP in this mechanism was further verified by the ability of c-AMP mimetics to mimic the pheromonotropic effect of brain extracts and PBAN. However, dose-response studies using PBAN and analogs suggest that PBAN induces a two mechanism response, one occurring at low PBAN concentrations (high affinity receptor) and another at higher PBAN concentrations (low affinity receptor).

MATING-INDUCED TERMINATION OF PHEROMONE PRODUCTION IN HELICOVERPA ZEA AND LYMANTRIA DISPAR. A. K. Raina, T.G. Kingan, J.M. Giebultowicz. Insect Neurobiology and Hormone Laboratory, U.S.D.A., A.R.S., Bldg. 306, BARC-East, Beltsville, MD 20705, U.S.A.

The production of sex pheromone in the females of several agricultural pest moths has been shown to be transiently or permanently suppressed following mating. The depletion of pheromone could, in principle, be attributable to either mechanical aspects of mating or to chemical messengers in the seminal fluid transfered by males along with spermatozoa. We have been studying these phenomena in the gypsy moth, *Lymantria dispar* (Lymantridae), and in the corn earworm moth *Helicoverpa zea* (Noctuidae). In *L. dispar*, the depletion of pheromone following mating occurs in two stages. The first stage is characterized by a transient suppression of pheromone for the first few hours following mating and is apparently attributable to mechanical aspects of the presence of the aedegus during mating. The second stage is a 'permanent' suppression of pheromone production, caused by the presence of spermatozoa in the spermatheca. Depletion of sex pheromone in *H. zea*, however, begins during mating and is nearly 100% complete within 2 hr after separation of the mating pair. In contrast to *L. dispar*, pheromone levels partially recover during the following scotophase, and the female will accept a male at this time. The transient suppression of pheromone in *H. zea* can be attributed to secretions of the accessory reproductive glands of males. We have purified a peptide from the accessory glands of male *H. zea* that is pheromonostatic in *H. zea* females. Preliminary evidence shows that separate accessory gland factors may account for the suppression of calling behavior associated with mating. Taken together, our findings suggest that a variety of mechanisms are expoited by different species to evoke a post-mating pheromonostasis.

LOWERING OF PHEROMONE LEVELS IN HELIOTHIS VIRESCENS BY SOME FACTORS ASSOCIATED WITH THE SEMINAL FLUID.

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Sex pheromone production in virgin females of Heliothis virescens peaks at the calling periods which are between the fourth and the seventh hour of scotophase on the second,third,fourth and fifth days following eclosion.Mating is known to cause drastic drop in the pherome level which does not recover until 48h after mating.Coupling females with males mated three times previously or 6-day-old males was less efffective in causing a sustained drop in pheromone titer which peaked again 24h after mating.A male factor which facilitates pheromone biodegradation is suspected to be transfered with the sperm.Further work indicated that this male factor could be ecdysone

The effects of Locust PBAN activity on sex pheromone production by female European Corn Borer Moth, *Ostrinia nubilalis*. Leam SRENG, Lab. Neurobiologie, LNB-8 "Communication chimique", 31, chem. Joseph Aiguier, 13402 Marseille cedex 09, France

Abstract - The presence of a PBAN-like (Pheromone Biosynthesis Activating Neuropeptide) substance from locust organs, (*Locusta migratoria*) has been demonstrated. Extracts of brain (BR), corpora cardiaca (CC), corpora allata (CA), suboesophageal ganglion (SOG) and thoracic ganglion (TG) of *L.migratoria* caused highly pheromonotropic response in decapitated females of the European corn borer moth (ECB) (*Ostrinia nubilalis*). The highest activity per unit weight of tissue was found in CC and CA of locust followed by BR+SOG of *O.nubilalis*. Following 8 days of disconnection, separating CA from CC and SOG, the pheromonotropic activity of CA was maintained at a level similar to that observed in intact organs, while that of CC and SOG was decreased. The effect of CA extract was heat stable but destroyed by proteases.

STRUCTURE AND ACTIVITY OF BOMBYX PBAN. H. Kuniyoshi, A. Suzuki (Department of Agricultural Chemistry, The University of Tokyo, Bunkyo-ku, Tokyo 113, Japan), H. Nagasawa (Ocean Research Institute, Nakano-ku, Tokyo 164, Japan) and T. Ando (Department of Applied Biological Science, Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183, Japan)

Pheromone biosynthesis activating neuropeptide (PBAN) of the silkworm, Bombyx mori, stimulates pheromone gland to produce sex pheromone, bombykol. Two molecular forms of Bombyx PBAN, PBAN-I and -II, were isolated and characterized. PBAN-I is a 33-residue amidated peptide and PBAN-II a 34-residue peptide with the same sequence as -I but with an additional Arg at the amino-terminus. They have sequence homologies not only with Heliothis PBAN but also with other insect peptides such as myotropic peptides and Bombyx diapause hormone. Structure-activity relationship of Bombyx PBAN was studied by synthesizing various kinds of analogs, revealing that (1) a sequence of at least carboxyl-terminal 5 residues including an amide is indispensable for the activity; (2) blocking of the amino-terminal amino group of a carboxyl-terminal hexapeptide by acetylation or benzoylation markedly increased the biological activity and the resulting modified peptides became much more stable in haemolymph than the original hexapeptide; and (3) oxidation of 3 Met residues caused a 100-fold increase in activity and it was found that each Met(O), methionine sulfoxide, equally contributes to the increase in activity.

ANALOGIES BETWEEN LEPIDOPTERA AND A DIPTERAN, THE HESSIAN FLY, *Mayetiola destructor* (Say).
S.P. Foster, DSIR Plant Protection, Private Bag, Palmerston North, New Zealand.

The Hessian fly (Diptera: Cecidomyiidae) has a pheromone-based mating system with a number of features in common with those prevalent in the Lepidoptera. Thus, females release a sex pheromone from a specialized area on the terminal segments of their abdomen that elicits males to fly upwind, over a distance of in excess of 1 metre, towards the source of the pheromone. As for certain species of Lepidoptera, pheromone production by female Hessian flies is cycled throughout their short lifetime, with peak pheromone titers occurring at the onset of the photophase, when copulation usually takes place. Pheromone production in female Hessian flies appears to be controlled by a factor originating from the head which is probably the pheromone biosynthesis activating neuropeptide (PBAN) or a related species found in many species of Lepidoptera. Mating stops pheromone production in female Hessian flies and lowers pheromone titer to virtually undetectable levels. It appears that a factor located in extracts of male abdomens, probably emanating from the male reproductive tract and transferred during mating, is responsible for this effect. Our studies on pheromone biosynthesis in two species of tortricid moths show interesting parallels with that in Hessian fly. However, while mating stops or slows pheromone production in these species, this effect does not appear to be mediated by humoral factors originating from the male. Possible physiological mechanisms mediating these effects in these tortricid species are discussed.

THE ROLE OF JUVENILE HORMONE AND ECDYSTEROIDS ON CUTICULAR HYDROCARBONS IN CALLIPHORA VOMITORIA (DIPTERA). Trabalon M.(Laboratoire de Biologie du Comportement, B.P. 239, 54506 Nancy, France), Campan M. (Laboratoire de Biologie du Comportement, 118, route de Narbonne, 31062 Toulouse, France).

In adult females of Calliphora vomitoria attractiveness is correlated with ovarian development which is controlled by the combined actions of ecdysteroids and juvenile hormone. Qualitative and quantitative changes in cuticular hydrocarbons synthesis/release were observed during the first gonadotropic cycle. A rise in total hydrocarbons parallels the first increase (24 hours, pre-vitellogenic period) in levels of the hormones. Female attractiveness begins later at 48 hours (after imaginal emergence), i.e. when all hydrocarbons (N=49, mainly alkanes and monomethyl-alkanes : 21 to 31 carbon atoms) were present,at maximal quantities (73 ug/female). Between 48 and 120 hours, hydrocarbon synthesis stabilizes as attractiveness. Relationships between attractiveness, cuticular hydrocarbons and hormones were studied by ovariectomies and allatectomies. Increasing and decreasing of some cuticular hydrocarbons implicated in the attractiveness were correlated with variation of the titer of the hormones, especially JH III.

FACTORS AFFECTING PHEROMONE PRODUCTION IN BEETLES. Desiree Vanderwel (Dept. of Chemistry, University of Winnipeg. 515 Portage Ave. Winnipeg, Mb, Canada. R3B 2E9)

Pheromone production and/or release by beetles is coordinated with a variety of physiological and environmental factors. To date, two basic mechanisms for the regulation of pheromone biosynthesis in beetles have been proposed. In some cases, pheromone biosynthesis is simply dependent on the availability of biosynthetic precursors. In others, certain stimuli or events trigger pheromone biosynthesis via hormonal action. Examples from the literature illustrating these two mechanisms will be reviewed. New information regarding the regulation of pheromone production in selected species of grain and bark beetles will be reported. For example, it is known that production of aggregation pheromone by the merchant grain beetle, *Oryzaephilus mercator,* is greatly enhanced in the presence of food. This production is apparently not dependent on the presence of dietary precursors, since this pheromone can be produced *de novo* in a closely related beetle. There is evidence to suggest that the regulation is hormonal in nature. The biosynthetic step subject to hormonal regulation has been tentatively identified.

ENDOCRINE REGULATION OF CALLING BEHAVIOR AND PHEROMONE PRODUCTION IN COCKROACHES. Coby Schal (Department of Entomology, Rutgers University, Cook College, New Brunswick, NJ, U.S.A.), Gary J. Blomquist (Department of Biochemistry, University of Nevada, Reno, NV 89557, U.S.A.)

Insects usually exhibit specific behaviors associated with sexual receptivity only when they are reproductively competent, and in insects with repeated reproductive cycles, these behaviors usually coincide with ovarian maturation. Juvenile hormone (JH) regulates various reproductive events including vitellogenesis, patency, and accessory sex gland maturation in cockroaches, and in some species JH also controls pheromone production, its release, and sexual receptivity.

Females of the German cockroach, *Blattella germanica*, produce a 4-component contact sex pheromone. We review evidence in support of the hypothesis that the precursor hydrocarbon 3,11-dimethylnonacosane is oxidized to the corresponding 3,11-dimethyl-2-nonacosanone pheromone. The *in vivo* synthesis of pheromone, its accumulation on the cuticle, and sexual receptivity in the female are correlated with the synthesis of JH by the corpora allata *in vitro*. Various experimental manipulations are used to show that environmental and intrinsic signals modulate the release of JH which then directly or indirectly influences sexual receptivity and pheromone production.

Females of the brown-banded cockroach, Supella longipalpa, release a volatile sex pheromone during a "calling" behavior. Data in support of the involvement of JH in regulating pheromone production and release (calling) are also reviewed.

JUVENILE HORMONES: THEIR ROLE IN THE REGULATION OF THE PHEROMONAL COMMUNICATION SYSTEM OF THE ARMYWORM MOTH, *PSEUDALETIA UNIPUNCTA*. Michel Cusson, Forestry Canada, Laurentian Forestry Centre, 1055 P.E.P.S., Ste-Foy, Quebec, Canada, G1V 4C7.

Since the discovery of the brain neuropeptide PBAN in 1984, much attention has been devoted to the elucidation of the endocrine and neuro-endocrine mechanisms regulating the biosynthesis and emission of sex pheromones in the Lepidoptera. So far, the available data indicate that the hormonal mechanisms involved vary considerably from one species to another. For instance, compelling evidence that juvenile hormones (JH) play a role in the control of sex pheromone production has been presented only for the armyworm moth, *Pseudaletia unipuncta*. Females that are allatectomized at emergence neither produce nor release pheromone, but both activities are restored following replacement therapy with synthetic JH. However, injection of synthetic JH in neck-ligated females does not induce pheromone biosynthesis whereas treatment with either a brain homogenate or synthetic PBAN causes an immediate rise in the pheromone titer, indicating that the role played by JH is an indirect one and that the tropic factor is almost certainly a PBAN-like substance.

Studies on *in vitro* JH biosynthesis by isolated corpora allata (CA) of *P. unipuncta* have shown that the low JH output observed early in the life of adult females is associated with their inability to "call" and produce pheromone. The subsequent increase in the rates of JH biosynthesis coincides with the onset of pheromone production and release. These results suggest that JH titers must pass a threshold level before the circadian release of PBAN begins. Whether the continuous presence of high levels of JH is necessary for pheromone production to be maintained or whether JH has a simple primer effect is currently being investigated. The possible role of JH acids in the receptivity of *P. unipuncta* males to the female sex pheromone will also be discussed.

ALLATOSTATINS OF THE COCKROACH: STRUCTURE AND IMMUNOCHEMICAL LOCALIZATION IN THE NERVOUS SYSTEM. Barbara Stay, (Department of Biology, University of Iowa, Iowa City, IA 52242 USA)

A family of five allatostatins, neuropeptides that inhibit juvenile hormone synthesis by corpora allata in vitro, has been isolated from the brain, corpora allata and pulsatile organ muscle of the cockroach Diploptera punctata. These peptides have from 8 to 18 amino acids and their similarity in structure is in the amino acids at the amidated carboxyl terminus. Cellular localization of the allatostatins has been determined with monoclonal antibodies against one of the allatostatins. The lateral neurosecretory cells of the brain deliver these peptides to the corpora allata through the nervi corporis cardiaci II. A branch of the nervi corporis cardiaci III carries allatostatins to the pulsatile organ muscle. Many other nerve cells of the brain and subesophageal ganglion are immunoreactive including interneurons. These results suggest that allatostatins have multiple functions.

Molecular Genetics of FMRFamide Neuropeptides of Drosophila. P. Taghert, L. Schneider, M. O'Brien, M. Roberts and C. O'Kelly, Dept. of Anatomy and Neurobiology, Washington Univ. Sch. of Medicine, St. Louis, MO 63110 USA

We are studying neuropeptide gene expression in *Drosophila* to define the functions of specific neuropeptides *in vivo* using genetic approaches. In particular we are analyzing the expression of a gene that encodes a series of FMRFamide-related peptides: the gene is first transcribed as a single RNA species from late embryonic stages. Using both RNA and antibody probes, *FMRFamide* expression can be detected in a stereotyped set of ~100 neurons in the adult nervous system. We are using molecular and genetic techniques to (i) identify enhancer/promotor regions surrounding the *FMRFamide* gene and to (ii) identify mutations. We will report on the definition of *FMRFamide* regulatory sequences: using P element-mediated germ line transformation, 6 constructs have been tested to date. The largest produces the entire cell-specific pattern; one of the smallest produces expression in one cell type only. We will also describe results of screening for *FMRFamide* mutants: we have screened ~3000 EMS-induced mutants and recovered 16 lethal mutations that map to within 50 kB of the gene. These 16 stocks define 3 complementation groups; we will present evidence to argue that one represents mutations in the *FMRFamide* gene.

AN OVERVIEW ON THE CHEMISTRY AND MOLECULAR BIOLOGY OF THE SILKMOTH *BOMBYX MORI*. Hironori Ishizaki(Department of Biology, School of Science, Nagoya University Nagoya, Japan) and Akinori Suzuki(Department of Agricultural Chemistry, Faculty of Agriculture, The University of Tokyo, Tokyo, Japan)

The present status of the knowledge on the prothoracicotropic hormone(PTTH) of Bombyx mori is presented. Bombyx PTTH is a 30 kDa homodimer or a dimer consisting of subunits differing only at the terminal short regions. The longest subunit consists of 109 amino acids and a carbohydrate moiety is attached to the 41st residue. The PTTH subunit is first synthesized as a 224-amino acid precursor protein. By analysis of recombinant PTTH produced by E. coli, the two subunits have been proven to be connected by a single disulfide bond. The gene encoding the prepro-PTTH subunit is present in a single copy per haploid Bombyx genome. The major site of the PTTH mRNA synthesis is the brain, but expression at very low levels occurs in various tissues including the gut. PTTH is produced by two pairs of dorsolateral neurosecretory cells of brain.

Molecular features of bombyxin, another Bombyx brain peptide that is structurally related to insulin and functionally like PTTH, are also reviewed.

Expression of Bombyx PTTH in Escherichia coli. H. Kataoka, J. Ishibashi, A. Suzuki (Department of Agricultural Chemistry, The University of Tokyo, Tokyo 113, Japan), A. Kawakami, H. Ishizaki (Biological Institute, Nagoya University, Nagoya 464, Japan)

Prothoracicotropic hormone (PTTH) of Bombyx mori is a homodimer of two identical peptide chains held together by disulfide bond(s) and each chain is composed of 109 amino acid residues. Since the content of PTTH in a brain was extremely small, estimated to be less than 1ng, we developed the expression system of Bombyx PTTH in E. coli using the T7 promoter vector pET3b to obtain sufficient amount of PTTH for exploring the tertially structure, physiological actions and the receptor. About 10mg of active recombinant PTTH were obtained from 1l of culture. Using the purified recombinant PTTH, the disulfide bond location was determined including an interdisulfide bond between two chains.

MOLECULAR APPROACHES TO THE STUDY OF ECLOSION HORMONE DIVERSITY AND EXPRESSION. J.W.Truman[1], F.Horodyski2, and L.M.Riddiford1. [1]Department of Biology, Univ. of Washington, Seattle WA, USA. [2]Dept. of Biochemistry, Univ. of Nevada, Reno, Nevada USA.

Eclosion hormone (EH) is produced in one or two pairs of ventral brain neurons (the VM cells), that project the length of the CNS as well as into neurohemal sites in the corpora cardiaca and/or the proctodeal nerve. These VM neurons are found throughout the insects and seem to be always associated with the production and release of EH.

The cloning of the EH gene from Manduca (Horodyski et al., 1989, PNAS, USA 86:8123) has allowed advances in a number of areas. One has been the use of molecular techniques to search for EH from other species. Another is the use of in situ hybridization techniques to monitor the levels of EH mRNA during the molt-intermolt cycle and during metamorphosis. A third is the use of recombinant systems to produce synthetic EH (Eldridge et al., 1991 Insect Biochem. 21:341). Recent progress in these areas will be discussed.

ECLOSION HORMONE-MEDIATED SIGNAL TRANSDUCTION AND CHARACTERIZATION OF THE ECLOSION HORMONE RECEPTOR IN SILKWORM ABDOMINAL GANGLIA. Norihisa Fujita, Hideaki Hayashi, Noriko Okada, Yuko Fujisawa, Michihiro Takai* and Yasuhiko Shibanaka.
Bio-organics and A&I* Depts., International Research Laboratories, CIBA-GEIGY (Japan) Ltd., P. O. BOX 1, TAKARAZUKA 665, JAPAN

Eclosion hormone (EH) is an insect neuropeptide which plays a crucial role in lepidopteran eclosion behavior. Since there is extremely little natural EH in insect brain, we obtained recombinant EH (rEH) from yeast. Subsequently, using the rEH, we elucidated the EH-mediated signal transduction in *Bombyx mori* and characterized the EH receptor.

Expression levels of the EH gene in yeast varied considerably with strains due to strain-specific protease activities. The strain AH22 produced rEH with the N-terminal intact in large quantities,100μg/L. The dose-response curve of the purified rEH for the induction of the eclosion behavior in *Bombyx mori* revealed an ED_{50} value of 0.2ng, a value very similar to native EH.

Injection of 8Br-cGMP induced the ecdysis behavior in silkworm pharate adults with a similar latency to that of rEH-induced ecdysis. The potency of 8Br-cGMP was 10^2 fold higher than that of cGMP and the efficacy was increased by the co-injection of IBMX, a phosphodiesterase inhibitor. The time course of sensitivity to the peptide corresponded directly with that of the cyclic nucleotide under the light and dark circadian rhythm. On the other hand, in silkworm pupal ecdysis both rEH and 8Br-cGMP induced the moulting behavior in a dose-dependent manner. Thus, throughout the silkworm life cycle, EH is effective at triggering the ecdysis behavior and cGMP plays a crucial role as the second messenger in the EH-mediated signal transduction.

Moreover, we will discuss the biochemical aspect of the rEH activated guanylate cyclase and the EH receptor mediated signal transduction in silkworm abdominal ganglia.

PSEUDOPEPTIDE AND PEPTIDE-MIMETIC ANALOG DEVELOPMENT FROM INSECT NEUROPEPTIDE TEMPLATES. Ronald J. Nachman, G. Mark Holman (U.S. Department of Agriculture, Agricultural Research Service, Food Animal Protection Research Laboratory, Route 5, Box 810, College Station, TX 77845)

Insect neuropeptides mediate a number of physiological processes critical for insect survival. The numerous neuropeptide sequences that have been reported present an opportunity to decipher the chemical and conformational requirements for neuropeptide-receptor interactions. Chemical and conformational requirements for activity represent a "template" from which agonist/antagonist peptide mimetics, with the potential to disrupt critical insect processes, can be developed. Information on structural requirements will be presented for three neuropeptide families--the sulfakinins, pyrokinins, and leucokinin/ achetakinins, including active core size, important side chains, peptide superagonists, and pseudopeptide modification of the N- and C-terminal regions. Members of these peptide families have been associated with a variety of physiological activities such as myotropism, pheromonotropism, diapause induction, and diuresis in a number of insects. Spectroscopic data coupled with computer molecular dynamics/graphics studies on conformationally-restricted analogs of insect neuropeptides reveal information on the active conformation adopted at the receptor site. Routes to development of peptide-mimetics from neuropeptide templates are discussed.

BACULOVIRUS EXPRESSION VECTORS EXPRESSING NEUROPEPTIDE GENES FOR INSECT CONTROL. S. Maeda (Department of Entomology, University of California, Davis, CA 95616, U.S.A.)

The effects of insect neuropeptide genes expressed by baculovirus expression vector systems were studied. Baculoviral expressed insect neuropeptide genes have been considered as safe and effective candidates for pest insect control. Bombyx mori larvae were mainly used in this study due to their ease of rearing, well defined physiology, and high sensitivity to neurohormones. Several insect neuropeptide hormone genes were prepared by DNA synthesis based on their amino acid or isolated cDNA sequences. These neuropeptide gene sequences were inserted after the polyhedrin promoter of the B. mori nuclear polyhedrosis virus and their insecticidal activity was tested. When a recombinant BmNPV carrying the diuretic hormone (DH) gene was injected into B. mori, reduction of hemolymph volume was observed three days post infection and mortality increased 25% compared to wild-type BmNPV infected larvae. The physiological and insecticidal effects of DH and other recombinant BmNPV expressed neuropeptide genes were analyzed.

REGULATION OF ECDYSONE 20-MONOOXYGENASE ACTIVITY IN THE TOBACCO HORNWORM *MANDUCA SEXTA*. John R. Crooks, Ekem T. Efuet, Daniel P. Keogh, Lydia J. Worford, Martin J. Mitchell and Stan L. Smith. (Department of Biological Sciences, Bowling Green State University, Bowling Green, OH 43403 U.S.A.)

Ecdysone 20-monooxygenase is the insect enzyme system responsible for the conversion of the molting hormone ecdysone to its more active metabolite 20-hydroxyecdysone. Previous studies by us and others have demonstrated that this insect monooxygenase system is a cytochrome P-450 dependent steroid hydroxylase with many properties similar to the vertebrate P-450 dependent cholesterol side-chain cleavage system. Our more recent studies on the regulation of the ecdysone 20-monooxygenase system in the tobacco hornworm *Manduca sexta* have revealed that it, like vertebrate steroid hydroxylases, is probably controlled in a multifactorial fashion involving the enzyme substrate and product, interendocrine factors and second messengers. During the last larval stadium of the tobacco hornworm, midgut ecdysone 20-monooxygenase undergoes a 50-fold increase in activity temporally coincident with the onset of the wandering stage. Radioassay quantifications of enzyme activity, in conjunction with injections and ligations, have revealed that the 50-fold increase in midgut ecdysone hydroxylase activity is predicated on m-RNA and protein synthesis, exhibits a head critical period temporally coincident with that for prothoracicotropic hormone, and can be elicited in competent head or thorax ligated pre-wandering animals by injections of ecdysone, 20-hydroxyecdysone, or the ecdysone agonist RH 5849 (1, 2-dibenzoyl-1-*tert*-butylhydrazine). Topical application of the juvenoids hydroprene or methoprene prevented the 50-fold increase in midgut enzyme activity in whole animals and head or thorax ligated pre-wandering animals injected with RH 5849. The 50-fold increase in midgut monooxygenase activity was also diminished by prior injections of calcium ions in conjunction with the calcium ionophore A 23187 or the second messenger cyclic AMP. By contrast, the second messenger cyclic GMP was found to elicit significant increases in midgut enzyme activity under *in vitro* conditions, and synergized with RH 5849 *in vivo*. In accord with these findings, injections of the guanylate cyclase inhibitor LY 83538 (6-anilinoquinoline-5, 8-quinone) mitigated the stimulatory effects of RH 5849 on midgut steroid hydroxylase activity. Supported by grants from FRC, Ohio Board of Regents, and NIH.

ENZYMES OF ECDYSTEROID METABOLISM. H.H. Rees, T. Cole, M. Kabbouh, Jian-Hua Chen, M.J. Fisher and R. Powls (Department of Biochemistry, University of Liverpool, P.O. Box 147, Liverpool L69 3BX.)

A major product of the prothoracic glands in Lepidoptera is 3-dehydroecdysone. This can be reduced by a haemolymph 3-oxoecdysteroid 3ß-reductase to ecdysone, which is converted, by ecdysone 20-monooxygenase in certain peripheral tissues into the hormonally more active, 20-hydroxyecdysone. After fulfilling their functions, ecdysone and 20-hydroxyecdysone undergo various inactivation reactions. In midgut cytosol of the Lepidopteran species, Spodoptera littoralis, these include transformation, via 3-dehydroecdysone, into 3-epiecdysone, which can undergo further phosphorylation. Amongst the prominent hormone inactivation reactions in the desert locust, Schistocerca gregaria, are transformation to 3-acetylecdysteroid 2-phosphate and, in follicle cells, to ecdysteroid 22-phosphate. The properties of the various enzyme systems catalysing the foregoing transformations will be considered.

ECDYSTEROID METABOLISM OF DIAPAUSE- AND NON-DIAPAUSE-DESTINED FLESH FLY LARVAE. Tetsuya Ohtaki (Department of Biology, Faculty of Science, Kanazawa Univ., 1-1, Marunouchi, Kanazawa 920 JAPAN)

Pupal diapause of the flesh fly is induced by a short day length during embryogenesis and larval development. The ring glands of larvae programmed for diapause release ecdysone without stimulation of PTTH at the pupation and then cease ecdysone secretion until termination of the diapause.

Ecdysone secreted at prepupal stage is rapidly metabolized to inactive ecdysteroids and conjugates. Free ecdysteroid is liberated from the conjugates in diapausing pupae and reused at the initiation of adult development. In nondiapause-destined larvae, formation of conjugate and liberation of free ecdysteroids at the adult development is not conspicuous and activity of their ring glands is directly controlled by PTTH. In the flesh fly, physiological and biochemical differentiations in endocrine systems between diapausing and non-diapausing animals are brought about by only several cycles of different photoperiods.

NEURAL CONTROL OF ECDYSONE BIOSYNTHESIS BY THE BRAIN OF BLOWFLY LARVAE. Evelyn Budd, Gerd Käuser, Jan Koolman (Physiol. Chem. Institut, University of Marburg, D-3550 Marburg, Germany)

The major source of the moulting hormone ecdysone in fly larvae is the ring gland. We have explanted ring glands and incubated them *in vitro* to study their secretory activity and to analyze their control by the brain.

Ecdysone was the major secretory product of ring glands dissected from blowfly larvae and incubated *in vitro*. Other secretory products such as 3-dehydroecdysone and 20-deoxy-makisterone A could not be detected when the glands were labelled *in vivo* with tritiated cholesterol. Ecdysone synthesis and secretion were found to be tightly coupled. Highest rate of secretion was observed a few hours before pupariation. *In vitro* the rate of ecdysone secretion by ring glands was affected significantly by coincubation with the brain. Modulating effects from the brain to the gland are obviously mediated both *via* haemolymph and nerve connections. Distinct parts of the brain revealed antagonistic effects on ecdysone secretion suggesting a much more complex control than is anticipated as yet. Multiple neural control systems appear to be involved. Moreover, these effects changed during the second half of the third instar reflecting a significant plasticity of neural control.

THE REGULATION BY ECDYSONE OF 1731,A DROSOPHILA RETROTRANSPOSON. M.Best-Belpomme, P.Ziarczyk, S.Simonart-Codani, J.Lacoste, J.Becker and F.Fourcade-Peronet. URA CNRS 1135, 7,quai St-Bernard 75005 Paris, FRANCE.

1731, a Drosophila melanogaster retrotransposon is a mobile genetic element which ressembles vertebrates retroviruses. Its internal gag and pol genes are flanked by two long terminal repeats (LTRs). The unidirectional transcription begins at the U3-R frontier of its 5'LTR and generates a major full length polyadenylated RNA whose level decreases with 20-hydroxyecdysone. Functional analysis of the 1731 LTRs shows that, in the U3 region, a short fragment (28 bp) presenting similarities with EcRE (Ecdysone regulatory element) is required for a double transcriptional regulation: positive by heat shock and negative by the steroid hormone. Moreover, a nuclear heparin-agarose fraction, including a Ponasterone specific binding activity contains a protein which binds specifically either an EcRE or the 1731 28bp U3 fragment. Cross competitions also suggest that this 1731 fragment is a target for the ecdysone receptor.

Molecular Genetic Analysis of the *Drosophila* ecdysone receptor. Michael Koelle, Will Talbot, Michael Bender, and David S. Hogness. Department of Biochemistry, Stanford Medical Center, Stanford, CA, 94305. USA.

The steroid hormone ecdysone regulates insect molting and metamorphosis. Its effects are mediated by the ecdysone receptor (EcR) protein, which functions as an ecdysone dependent transcription factor. In *Drosophila*, the EcR gene produces at least three EcR isoforms through use of multiple promoters and alternative RNA splicing. The EcR protein isoforms have different temporal and spatial expression patterns, and thus may, at least in part, account for the tissue and stage specific effects of ecdysone. Mutations that inactivate all EcR gene products result in embryonic lethality, showing that EcR, and perhaps ecdysone, have vital roles in embryogenesis. Mutants that inactivate only the EcR B1 isoform die at the onset of metamorphosis, indicating that this isoform is not required for the earlier larval molts. When expressed in mammalian cells or yeast, the EcR protein is inactive for hormone and DNA binding unless a *Drosophila* protein extract is added to it, indicating that a second Drosophila protein in addition to EcR is required to make a functional receptor. This second protein may be another subunit of the receptor. In fact, when purified from *Drosophila* tissue culture cells, the ecdysone receptor protein appears to consist of two tightly complexed subunits, one being the EcR protein, and the other being a novel 70 kD protein.

PUTATIVE ECDYSTEROID-INDUCED TRANSCRIPTION FACTORS IN THE WAX MOTH *GALLERIA MELLONELLA*
Marek Jindra, Frantisek Sehnal and Lynn M Riddiford*. *Institute of Entomology, Ceske Budejovice, Czechoslovakia; *Department of Zoology, University of Washington, Seattle WA, U.S.A.*
Ecdysteroids initiate and coordinate molting in insects. In *Drosophila* several of the "early" genes directly induced by ecdysteroids code for DNA-binding proteins, some of which belong to the steroid receptor superfamily. These genes may play important roles in hormone-dependent transcriptional regulation of other genes. We have found two distinct DNA sequences in the wax moth *(Galleria mellonella)*, which are strongly similar to some ecdysteroid-inducible genes encoding DNA-binding zinc finger motifs. The first one is a genomic sequence involving a 144 bp open reading frame that is 77% identical to the *Drosophila* "early" gene *E75* (100% at the amino acid level). The homology maps to the central part of *E75* encoding one zinc finger motif of its DNA-binding domain. The second *Galleria* sequence has been obtained by means of PCR amplification of cDNA derived from larvae during the molt-inducing ecdysteroid titer. The primers used for amplification were designed to match several selected C_2C_2 zinc finger motifs known in insects and vertebrates. One of the resulting PCR products involves a 177 bp sequence revealing 75% identity to the *Drosophila* gene *DHR3* and 87% to the *MHR3* gene of *Manduca sexta*. The deduced protein sequence is 97 and 100% identical to the DNA-binding regions of *DHR3* and *MHR3*, respectively. The above comparisons suggest that *Galleria* counterparts of *Drosophila* and *Manduca* ecdysteroid-inducible genes have been discovered. Developmental studies of expression of these *Galleria* genes are under way.

ECDYSONE RESPONSE ELEMENTS. P. Cherbas, L. Cherbas, K. Lee, A. Andres (Department of Biology, Indiana University, Bloomington, IN 47405, USA)

Four ecdysone response elements (EcREs) have been identified in the Drosophila genes Eip28/29 and hsp27. These elements are short partial palindromes, of the form PuG(G/T)TCANTGA(C/A)CPy, and they are binding sites for the ecdysone receptor. Insertion of an EcRE into a reporter plasmid not only confers ecdysone inducibility upon the reporter; it also causes a decrease in the basal (ecdysone-independent) expression of the reporter. In Eip28/29, a region downstream of the transcription, containing 2 EcREs, is both necessary and sufficient for ecdysone induction in Kc cells, hemocytes, and the cardia. A third EcRE, located 450 bp upstream of the transcription start site, is neither necessary nor sufficient for the response, although it can confer a weak ecdysone response in a test plasmid. By contrast, Eip28/29 is repressed by ecdysone in the epidermal cells; in these cells, only the upstream region is required for proper regulation. Thus, the tissue-specific response of Eip28/29 to ecdysone appears to be mediated by tissue-specific EcREs.

FUNCTIONAL AND DEVELOPMENTAL SPECIFICITY IN PHEROMONE AND GENERAL-ODORANT DETECTION BY LEPIDOPTERA: BINDING PROTEINS, DEGRADING ENZYMES, AND MEMBRANE-BOUND RECEPTORS. Richard Vogt (Department of Biological Sciences, University of South Carolina, Columbia SC 29208, USA)
The antenna represents a mosaic of distinct classes of olfactory sensilla: one class detects pheromone odorants while a second class detects general environmental odorants. Specificity of odorant detection appears to be governed by biochemical interactions between odorants and antennal-specific sensilla proteins. Multiple classes of odorant binding proteins (OBP) have been identified, cloned and sequenced. Pheromone binding proteins (PBP) uniquely associate with the pheromone specific sensilla, while general-odorant binding proteins (GOBP) associate with the general-odorant sensitive sensilla. Odorant degrading enzymes (ODE) have been identified and characterized for both acetate-ester and aldehyde pheromones. While the esterase associate only with the pheromone specific sensilla, the aldehyde oxidase associates with both pheromone specific and general-odorant sensitive sensilla and is thus multifunctional. A major membrane associating protein of the sensory dendrite was previously shown to bind pheromone, and was thus implicated as a pheromone receptor protein. However, full length sequence analysis of this protein indicates homology with vertebrate receptor proteins involved in cell-cell interaction, and thus suggests an alternative but important role in regulating the development of the olfactory neuron. The roles these proteins and their developmental regulation play in determining odor specificity will be discussed.

HORMONE RECEPTORS AND TRANSCRIPTION FACTORS IN MANDUCA EPIDERMIS. Subba Reddy Palli, Rosalie Langelan, Kiyoshi Hiruma, and Lynn M. Riddiford. Department of Zoology, University of Washington, Seattle, WA 98195, USA.

In the epidermis the molting ecdysteroid rise and fall suppresses intermolt gene transcription, activates genes associated with new cuticle production, and coordinates cellular events associated with ecdysis and sclerotization. These events are not a direct action of ecdysteroid but are dependent on protein synthesis. Early in the molt ecdysteroid activates expression of MHR3, a member of the steroid hormone receptor superfamily for which the ligand is unknown. *In vitro* experiments show that the MHR3 gene is directly activated by 20-hydroxyecdysone (20HE), dependent of 20HE for its continued expression, and suppressed by itself or another protein induced by 20HE. Experiments in progress are determining whether this factor binds to either an intermolt cuticular gene or to the molt-related dopa decarboxylase gene. *In situ* hybridization and immunocytochemical studies show that MHR3 is a nuclear protein that is expressed in both a tissue-specific and within a segment in a region-specific pattern that correlates well with the sensitivity of these tissues to ecdysteroid during the molt. Hence, those that require only a short exposure to the rising ecdysteroid in order to molt such as the crochet epidermis show MHR3 expression very early as compared to the abdominal epidermis. The pattern of ecdysteroid receptor expression and the timing of the loss of the MHR3 protein relative to new cuticular deposition are presently under study. These studies suggest that MHR3 is an ecdysteroid-induced transcription factor that is critical to the ecdysteroid-induced cascade of events that occur in the epidermis during a molt.

ALLATOSTATIN RECEPTOR PROTEINS IN THE COCKROACH *DIPLOPTERA PUNCTATA*. Michel Cusson (Forestry Canada, Laurentian Forestry Centre, 1055 P.E.P.S., Ste-Foy, Quebec G1V 4C7 Canada), Glenn D. Prestwich (Department of Chemistry, State University of New York, Stony Brook, New York 11794-3400, USA), Barbara Stay (Department of Biology, University of Iowa, Iowa City, IA 52242 USA), and Stephen S. Tobe (Department of Zoology, University of Toronto, Toronto, Ontario M5S 1A1 Canada).

In the viviparous cockroach, *Diploptera punctata*, juvenile hormone (JH) biosynthesis is under the regulation of inhibitory brain neuropeptides termed allatostatins (AST). The demonstrated sensitivity of isolated corpora allata (CA) to these neurohormones is indicative of the existence of AST-specific receptor(s) within those glands. To identify AST binding proteins, we used an azidosalicylamide (ASA) photoaffinity analogue of AST-1. Incubation of the 100,000 x *g* membrane pellet from female *D. punctata* CA with [^{125}I]-ASA-AST-1, followed by irradiation (254 nm, 4°C, 30 sec), SDS-polyacrylamide gel electrophoresis, and autoradiography revealed the presence of a major 59 kDa band and a minor 39 kDa band, both showing competition by excess AST-1 or AST-3. Presumably, these proteins are components of AST receptor(s). Among the other tissues tested, the brain and abdominal fat body also contained AST-specific binding proteins (brain: 41 kDa; fat body: 38, 41 and 60 kDa) whose roles are as yet undetermined.

We compared the density of the 59 kDa band between two groups of CA showing different levels of *in vitro* sensitivity to AST. The density of the band was greater for the more sensitive CA, suggesting that cyclical variations in the level of AST-induced inhibition of juvenile hormone biosynthesis may occur as a result of changes in the number of receptor sites within the CA. Work is currently underway to further characterize the aforementioned proteins.

CUTICULAR AND TRACHEAL COMPONENTS OF INTEGUMENTARY TRANSPIRATORY WATER LOSS. J. Noble-Nesbitt (School of Biological Sciences, University of East Anglia, Norwich, UK).

Spiracular control can regulate tracheal loss over a wide range. Cuticular loss is less easily studied, but also shows a range. It is much lower than previously believed. Gravimetric determination of transpiration rates does not readily discriminate between cuticular and tracheal components of water loss, although continuous weight records provide useful information. A more sensitive discrimination is provided by the use of radioactive tritiated water. Using this method with the cockroach, *Periplaneta americana*, tracheal bursts are readily distinguishable from the basal, interburst level of transpiration, that must be mainly if not entirely cuticular.

Comparative measurements show that the euticular permeability of the cockroach, that has a grease-like waterproofing epicuticular lipid, can be much less than would be expected of a hydrocarbon lipid of similar viscosity and lower even than that of a solid hydrocarbon wax. Equally, however, our studies indicate that its permeability is variable and can be reduced when the insect is desiccated. A theoretical model suggests that reduction of the water content of the cuticle, possibly by the epidermis and under endocrine regulation, can provide an hydraulic force that may be responsible for imposing a much higher than expected molecular organising force on the superficial epicuticular lipid, so reducing its permeability reversibly. There is clear experimental evidence of changes in the nature of the cockroach's waterproofing epicuticular lipid.

REGULATION OF CROP EMPTYING IN LEPIDOPTERA: IMPLICATIONS FOR THE CONTROL OF DIURESIS. D. Bushman, (Mount Saint Mary's College, Emmitsburg, MD 21727, USA)

A post-feeding diuretic response has been observed in adult *Helicoverpa zea* (Lepidoptera: Noctuidae). Two day old starved adults which were allowed to feed to repletion on a 10% (w/v) sucrose solution lost 49.1% (females) and 85.8% (males) of the weight of the ingested meal during the first hour following feeding. Ligation between head and thorax or frontal ganglionectomy, when performed immediately following feeding, each resulted in a significant and permanent reduction in this normal weight loss. Injection of homogenates of the corpora cardiaca/corpora allata (CC/CA) complex into unligated insects immediately after feeding also significantly reduced the post-feeding weight loss, but this inhibition was transient and disappeared after one hour. Dissection and weighing of the crop from either ligated, frontal ganglionectomized, or CC/CA injected insects confirmed the crop as the predominant site of fluid retention in each case. We suggest that a soluble antidiuretic factor from the CC/CA acts in conjunction with the frontal ganglion to control the rate of crop emptying and subsequent diuresis by regulating the volume of ingested fluid that is passed into the haemolymph from the crop/midgut.

TOWARD A FUNCTIONAL RATIONALE FOR THE STRUCTURE OF INSECT MIDGUT GOBLET CELLS. D.F. Moffett, (Zoology Department, Washington State University, Pullman, WA 99164-4236 USA).

The distinguishing feature of the goblet cell is its large apical cavity, separated from the gut lumen by a complex valve. Conventional and ion-specific microelectrode measurements show K^+ activity in the goblet cavity above electrochemical equilibrium and Cl^- activity below equilibrium, in accord with active secretion of K^+ and absorption of Cl^- across the goblet cell apical membrane. Current hypotheses of goblet cell-mediated transepithelial ion transport assume ionic diffusion through the valve. To measure valve patency, microelectrodes filled with tetramethylammonium (TMA^+)-sensitive resin were inserted into goblet cavities and the apical surface of the gut was superfused with 5 mM (TMA^+). Most cavities were not accessible to TMA^+; turnover times computed from TMA^+ influx and washout rates for the "open" cavities were not less than 16 min. These results are inconsistent with free diffusion of K^+ and Cl^- through the valve. Possible rationales for the adaptive significance of the goblet cavity and mechanisms for ionic movement between the cavity and gut lumen will be presented. Supported by NSF DCB 8811354.

REGULATION OF MIDGUT ION TRANSPORT PROCESSES IN LARVAL LEPIDOPTERA. J.A.T. Dow, J-P Sumner, Fergus Earley* and Kim Kaiser†, (Departments of Cell Biology and †Genetics, University of Glasgow, Glasgow, G12 9QQ, UK, and *ICI Agrochemicals, Jeallott's Hill, Bracknell, Berks, RG12 6EY, UK).

The midguts of larval lepidoptera are characterised by multiple ion transport processes: a highly electrogenic K^+ transport into the lumen producing open-circuit PDs over 150 mV, which is based on a plasma-membrane vacuolar H^+-ATPase and a K^+/H^+ exchanger; and an overall luminal alkalinisation, which can produce luminal pH values *in vivo* in excess of 12. All of these transport processes are believed to co-reside on the plasma membrane of a unique "goblet" cell. Although the underlying vacuolar ATPase is in the opposite orientation required to produce a luminal alkalinisation, these processes have been shown to be closely linked *in vitro* by applying reversible anoxia to the tissue. We have studied the control of these processes by measuring their activities in the fourth and fifth larval instars, and during the 4th-5th instar moult. We show here that feeding activity (determined by inspection), electrogenic K^+ transport (measured as open circuit PD across isolated guts), luminal high pH (assessed non-invasively with dietary pH-sensitive dyes), and vacuolar ATPase activity (measured biochemically on isolated goblet cavity membranes), are normally all lost about 12 h before ecdysis, and all recover 2-3 h after ecdysis, with similar timecourses. This suggests the exciting possibility that these processes may be co-ordinately controlled by the insect.

MOLECULAR ANALYSIS OF THE ELECTROGENIC POTASSIUM PUMP IN THE TOBACCO HORNWORN MIDGUT. H. Wieczorek, B. Förg-Brey, R. Gräf, W.R. Harvey[1], U. Klein, A. Lepier, F. Novak[1], (Zoologisches Institut der Universität, Luisenstr. 14, W-8000 München 2, Federal Republic of Germany[1]; Department of Biology, Temple University, Philadelphia, PA 19122, USA).

Evidence has now accumulated that active and electrogenic K^+ secretion in the larval midgut of *Manduca sexta* results from electrogenic H^+ transport by a vacuolar-type ATPase (V-ATPase) energizing electrogenic K^+/nH^+ antiport.

The immunoaffinity-purified V-ATPase consists of at least nine polypeptides: M_r 67,000, 56,000, 53,000, 43,000, 40,000, 28,000, 16,000 and 15,000. Several additional polypeptides in range of M_r 35,000 to 30,000 may also be constitutional components of the enzyme.

Complementary DNA's for the 67,000 and 56,000 subunits screened by monoclonal antibodies to the 67,000 subunit of the *Manduca* V-ATPase or by hybridisation with a cDNA probe for a plant V-ATPase 56,000 subunit have been cloned and sequenced. There is a high degree of homology to the sequences of the respective subunits of other V-ATPases.

The V-ATPase was immunolocalized using monoclonal antibodies to defined subunits of the *Manduca* V-ATPase. The antibodies labelled the apical membranes of goblet cells along the whole midgut.

Present lines of research include the analysis of K^+/nH^+ antiport stoichiometry, cloning and sequencing of further subunits of the V-ATPase including the regulatory gene sequences, and the isolation of the K^+/nH^+ antiporter.

THE APICAL MEMBRANE OF MALPIGHIAN TUBULES (*FORMICA*) CONTAINS AN ELECTROGENIC H^+ATPASE AND A K^+/H^+ ANTIPORTER: ELECTROPHYSIOLOGICAL EVIDENCE. Van Kerkhove E. (LUC, 3590 Diepenbeek, Belgium).

Malpighian tubules of *Formica* secrete K^+, followed by Cl^- and water, against a transepithelial electrochemical gradient. The active step of K^+ transport is located in the apical membrane. Wieczorek *et al.* (Biochim. Biophys. Acta **857**, 271-281, 1986) proposed that a V-type H^+-ATPase in the apical membrane of another insect epithelium (midgut of *Manduca sexta*) is the prime mover in K^+ secretion. The H^+ pump builds up a proton gradient across the membrane. The latter gradient is then used by a K^+/H^+ antiporter to extrude K^+ from the cell into the lumen. In spontaneously secreting Malpighian tubules of *Formica* luminal and intracellular measurements with double-barelled H^+-sensitive microelectrodes showed that active transepithelial proton secretion occurs and that a large (103 mV) electrochemical H^+ gradient is built up across the apical membrane. In control Ringer (51 mM K^+, 57 mM Cl^-, pH=7.25) the cell pH is alkaline (7.81 ± 0.04 S.E., n=19) with respect to the lumen (7.45 ± 0.09 S.E., n=12). Furthermore when comparing the concentration gradient for K^+ ($[K^+]$cell/$[K^+]$lumen = 1.6), measured with K^+-sensitive microelectrodes, and H^+($[H^+]$cell/$[H^+]$lumen = 2.3) across the apical membrane, it is clear that the cell inward gradient for H^+ is large enough to drive K^+ extrusion with an electroneutral antiporter, exchanging 1 K^+ for 1 H^+.

A VACUOLAR-TYPE ATPASE AS ENERGIZING PRINCIPLE IN INSECT ION TRANSPORTING EPITHELIA. AN IMMUNOLOGICAL APPROACH. U. Klein, G. Löffelmann, A. Speiser, B. Zimmermann[1], H. Wieczorek (Zoologisches Institut der Universität. Luisenstr. 14, W-8000 München 2, Federal Republic of Germany; [1]Institut für Zoologie der Universität, Universitätsstr. 31, W-8400 Regensburg, Federal Republic of Germany).

Electrogenic K^+-transport in insects serves as energy source in gastrointestinal and sensory epithelia. In the larval midgut of the sphinx month *Manduca sexta*, a vacuolar-type H^+-pump (V-ATPase) and a K^+/nH^+-antiport represent the functional elements of the K^+-pump. Monoclonal antibodies to the purified V-ATPase localized the antigen in the membrane projections of the goblet cell apical membrane, the site of active K^+-transport. In immunoblots, an immune serum to the purified midgut V-ATPase cross reacted with crude homogenates of sensilla-rich antennae and Malpighian tubules of the sphinx moth. Immunocytochemical investigations with monoclonal antibodies to defined subunits of the midgut V-ATPase localized immunologically related epitopes in the apical membrane of the brush border of Malpighian tubules in the sphinx moth and of auxiliary cells of antennal sensilla in a saturniid moth.

These findings deliver strong evidence that all ouabain-insensitive electrogenic ion transport in insect epithelia may be energized by a V-ATPase. The locust rectum exhibiting an active Cl^--transport, is currently under immunocytochemical investigation. Furthermore, these results support the hypothesis that a V-ATPase provides an alternative to the NA^+/K^+-ATPase in energizing animal plasma membranes.

RECTAL WATER VAPOUR ABSORPTION. J. Noble-Nesbitt (School of Biological Sciences, University of East Anglia, Norwich, UK).

Three main systems for rectal absorption of water vapour have been described.

The highly complex apical region of the rectal (anal) sac cells of the firebrat, *Thermobia domestica*, indicates that this region is responsible for driving vapour absorption. De- and re-differentiation during the moulting cycle coincides with the loss and regaining of the capacity to absorb water vapour. Tidal ventilatory movements seem to assist absorption, but fine measurement of volume changes during vapour absorption do not support a suggested involvement of pressure pulses in vapour condensation in the firebrat.

The dorsal gutter cells in the rectal sac of the larval rat flea, *Xenopsylla cheopsis*, have a fine structural arrangement closely similar to that of the rectal sac cells of the firebrat and partly on this basis are thought to be responsible for vapour absorption.

Morphometric analysis of osmotic and ionic concentrations across and along the larval cryptonephric complex of the mealworm, *Tenebrio molitor*, indicate that the secretory activity of the tubule epithelium could drive passive absorption from rectal vapour to tubule fluid. Intervening cellular and fluid compartments are reduced to a minimum at the most posterior part of the complex where gradients are greatest. However, differences between the rectal epithelium of the larva (vapour absorptive stage) and imago (non-vapour absorptive stage) indicates an important role for the rectal epithelium in the vapour absorptive system.

WATER BALANCE AND OSMOREGULATION IN WEEVIL LARVAE (COLEOPTERA: CURCULIONIDAE) FROM THREE DIFFERENT HABITATS ON SUBANTARCTIC MARION ISLAND. S.L. Chown (Department of Entomology, University of Pretoria, Pretoria 0002, South Africa)

Ectemnorhinine weevils are the most successful group of beetles in the subantarctic region, which is undoubtedly due partly to their ability to tolerate a wide variety of abiotic conditions. In the laboratory, larvae of three species, from three diverse habitats on Marion Island, were exposed to desiccating conditions and to water of two different salinities to elucidate the physiological basis of their ability to tolerate various abiotic conditions. In the desiccation experiment, the supralittoral *Palirhoeus eatoni* (C.O. Waterhouse) larvae lost water faster than larvae of the "inland" epilithic species, *Bothrometopus randi* Jeannel, and could not fully replenish lost water by drinking. However, larvae of *P. eatoni* showed greater osmoregulatory ability than the latter species when exposed to hypo- and hyperosmotic conditions. The detritus-dwelling larvae of *Ectemnorhinus similis* C.O. Waterhouse showed rates of water loss similar to those of the *B. randi* larvae in the desiccation experiment, but took longer to replace lost water by drinking. All three species showed little change in haemolymph water activity despite approximately 28 per cent reduction in water content during desiccation. These physiological responses seem to reflect an equilibrium between the species and their environments which may be considered an adaptation in the case of *B. randi*, but which appear to be superfluous, and a result of phylogenetic constraint, in *E. similis*. *P. eatoni*'s status as a "marine" weevil is confirmed.

FROM GENES TO NETWORK ANALYSIS: A MULTIDISCIPLINARY APPROACH TO THE VISUAL SYSTEM OF *DROSOPHILA*: Erich Buchner, Sigrid Buchner, Alois Hofbauer, Gert Pflugfelder, Konrad Zinsmaier, Gertrud Heimbeck, Rita Reifegerste, Claudia Faust, Kai Eberle, Bert Klagges, Stefan Grimm (Institut für Genetik und Mikrobiologie der Universität, Röntgenring 11, D-8700 Würzburg, Germany)

In spite of decades of intensive research the neurosciences still face dramatic challenges. At the molecular level genetic complexity of brain tissue indicates that more than 90% of the proteins responsible for the structural and functional differentiation of its components remain unknown. At the systemic level a wide gap persists between our knowledge of the physiology of the single neuron and our understanding of the computational performance of a nervous network.

Molecular cloning of genes expressed in functionally important subcellular compartments such as synapses or in subpopulations of identified interneurons in the visual system of *Drosophila* may provide the basis both for the characterization of new brain proteins and for the controlled manipulation e.g. of the visual movement detection network of dipteran insects by selective elimination of sets of neurons using molecular genetic techniques presently developed in various laboratories.

Applying the approach "from antibody to gene" we have cloned three genes (*csp, dsyn, nc46*) for presumed synapse-associated proteins and a gene (*dcb*) for a calcium-binding protein that is selectively expressed presumably in L2 and T2/T3 cells of the optic lobes and in various unidentified neurons of the medulla and other parts of the nervous system of *Drosophila*. Sequence analysis of these genes demonstrates that *csp* and *nc46* code for new brain proteins such that it will be interesting to search for vertebrate homologs, while *dsyn* and *dcb* represent the first invertebrate members of the vertebrate synapsin and calbindin protein families, respectively. Mutations in these genes are presently induced and investigated in order to obtain information on the molecular, cellular and systemic functions of these proteins and the cells expressing them.

HOW WELL DO INSECTS SEE IN THE DARK? Eric J. Warrant, Department of Zoology, University of Lund, Lund, Sweden.

Nocturnal and crepuscular-insects have certain adaptations for vision at low light intensities. At the most peripheral level of the visual system, the eye, these insects often possess superposition optics which maximise the capture of photons, but frequently sacrifice spatial resolution. The amount of spatial information that can be extracted from a scene, at a given mean light intensity, depends on this trade-off between resolution and sensitivity. Simple calculations, based partly on the expected photon noise and partly on the experimentally determined receptive field profiles of photoreceptors, can estimate the range of spatial frequencies detectable by an eye. The results of such calculations will be discussed for the superposition eye of the crepuscular dung beetle Onitis alexis, and compared to calculations made for other eye designs (including the apposition type) subjected to the same light intensities. Various strategies for vision by insects at low light levels (eg. alteration of receptive field properties and neural pooling) will also be discussed.

CLASSIFICATION AND SELECTION OF VISUAL TARGETS IN DROSOPHILA
K.G. Goetz, Max-Planck-Institut für biologische Kybernetik, Spemannstr. 38, D-7400 Tübingen, Germany.

Flies improve the efficiency of search for rewarding targets by comparatively simple strategies of orientation which have been studied in fixed flying or free walking animals. The results demonstrate the evaluation of at least three properties of the preferred targets:

Proximity. Using motion parallax between figure and ground as a criterion, searching flies are likely to select the nearest targets for exploration. This increases the number of trials per pathlength. Remote figures appear to be embedded in the ground, and do not elicit long lasting curiosity.

Novelty. Choice between two or more inaccesible figures can be characterized by a high rate of trials and by an equidistribution of visits, independent of the differences in figure-specific attraction. This is achieved by *sustained spontaneous alternation* (SSA) of the preferred target. SSA disengages the flies from non-rewarding targets. The strategy is reminiscent of sustained spontaneous depth reversal in human perception of ambiguous figures such as as the Necker cube. SSA is likely to exist in other experimental animals, and may have concealed their ability for pattern discrimination and learning.

Ubiquity. The persistence of direction in the trajectories of flies gradually increases with the time spent in the absence of favourable sensory cues. This strategy is reversible and extends the radius of area-covering search by a factor of up to ten until the flies hit upon rewarding targets.

DISTRIBUTION AND PROPERTIES OF THE SEX-SPECIFIC PHOTORECEPTOR OF THE COMPOUND EYE IN INSECTS Weiguo Wu, Meiying Wu, Zhimin Xu, Shuzheg Shi (Institute of Biophysics, Academia Sinica, Beijing 100101, China)

The results are as follows: 1. The sex-specific photoreceptor central retinula cells R7 extend to ventral region from the dorsal region in male Diptera, including housefly, horsefly and blowfly. 2. The rhabdom of the sex-specific central retinula cell extends to the basement membrane and keeps abreast of the rhabdom of the central retinula cell R8 in male housefly and horsefly, but does not extends to the basement membrane in male blowfly. 3. The sex-specific central retinula cells in the compound eye of the female Diptera are only distributed in the ventral region of the compound eye and are very less numerous than nomoral retinula cells in the same region.

LIGHT-ACTIVATED CHANNELS IN *DROSOPHILA* PHOTORECEPTORS.
R.C. Hardie (Cambridge University Department of Zoology, Downing St, Cambridge CB2 3EJ, U.K.).

It has recently proven possible to make patch-clamp recordings from a preparation consisting of dissociated ommatidia from the *Drosophila* compound eye. The combination of high resolution voltage-clamp measurements and molecular genetics possible with this preparation is likely to be of enormous benefit for studies of invertebrate phototransduction. Measurements of the whole-cell currents have identified at least two distinct ionic components to the *Drosophila* light-activated conductance. By determining the effect of extracellular Ca^{2+} on reversal potential, it is shown that one class of channel is highly permeable to Ca^{2+} and is selectively blocked by external La^{3+}. This light-activated Ca^{2+} channel is absent in the *trp* mutant, suggesting that *trp* may be the structural gene for this channel. It is also concluded that Ca^{2+} entry via the *trp* dependent channel plays a dominant role in determining the kinetics of both excitation and adaptation and is obligatory for maintained light-excitation in fly photoreceptors.

REAL-TIME VISUOMOTOR CONTROL: FROM FLIES TO ROBOTS
N.Franceschini, J.M.Pichon, C.Blanes (C.N.R.S., LNB; 31, Chemin. J. Aiguier; 13009, Marseille France)

In an attempt to explore how motion detection could possibly serve obstacle avoidance, we conceived a terrestrial creature with a compound eye, which moves around and avoids obstacles by visually evaluating its own motion relative to the environment. The eye is made of 100 ommatidia, with facet lenses, rhabdomeres, and photoreceptors. The first 'optic ganglion' is devoted to signal conditionning, the second 'optic ganglion' is a retinotopic array of 100 columnar Elementary Motion Detectors (E.M.D's) which drive a third 'optic ganglion' devoted to obstacle avoidance. The E.M.D. circuits were copied from those of the fly, as analysed by single photoreceptor stimulation combined with single neurone recording. Conceiving this fully autonomous, sighted robot strongly emphasized the connections which have to exist between perception and action in both artificial and natural creatures. The purely analogue implementation is a brainlike solution to a typical sensorimotor problem: how to fuse hundreds of sensory input signals to a single, intelligent steering command.

NEURONS MEDIATING VISUAL FLIGHT CONTROL IN *LOCUSTA*. Michael Geweeke (Zoologisches Institut, Universität Hamburg, Martin-Luther-King-Platz 3, D-2000 Hamburg 13, Germany), Tiande Hou (Biology Department, Northwestern Normal University, Lanzhou, Gansu, China)

In the insect brain those neuronal pathways which are involved in an essential behaviour, e.g. the optomotor control of movement and locomotion, are of speeial interest. At different levels of the visual pathway information is focussed upon giant interneurons which function both as interfaces and as matched filters by transforming the input of hundreds of visual sense cells, first or second order neurons, onto a relatively small number of descending neurons. By this means they form abstract representations of the animal's visual environment.

The dendritic arborizations of the visual giant interneurons of *Locusta migratoria* are spred within the optie lobe, i.e. lamina, medulla or lobula. The axonal endings project into the eentral part of the protocerebrum, into its lateral parts on either one or both sides, or even into the eontralateral optie lobe. To discover these types of neurons we used a video film for lateral visual stimulation, including different black and white, stationary or moving patterns. By intracellular recording and staining with Lucifer Yellow the neurons were identified physiologieally and anatomieally.

Out of twenty-five types of visual neurons identified four were only light (on or off) sensitive, eighteen in addition were sensitive to dots or bars moving in any direetion (non-directionally movement-sensitive neurons), and three others, with dendritic fields within the lobula, were exeited by pattern movement in only one horizontal direction in eaeh ease (direetionally sensitive movement detectors). The latter might thus be eomponents of the visual pathways controlling optomotor behaviour, e.g. flight control.

MOTION COMPUTATION IN THE VISUAL SYSTEM OF THE FLY. Ai-ke Guo (Laboratory of Visual Information Processing, Institute of Biophysics, Academia Sinica, Beijing, China)

The computation of motion information by visual system comprises at least two principle steps:local motion detection by elementary motion detectors and global spatial intergration by physiological mechanisms. Local response vectors normally point into directions differet from the direction of the local pattern velocity vector. The deviation angle changes with the local brightness structure of the moving pattern . How then is a visual system able to predict the trajectory of a moving object if the computed motion field, generated by an array of motion detectors strongly depends on the patterning or the shape of moving object? One possibility seems to be realized in the visual system of the fly, so for instance by the Figure-Ground discrimination system. The computer simulations show that the FD-system (SF-system) is able to provide a sloppy correction of the deviation angle. This is not so for the wide angle H-system (LF-system). The parameters n and q, T ank K(Reichardt,Egelhhaf and Guo, 1989) may be very important for sloppy compesation. (Acknowledgement: I am greatly indebted to Prof. Dr. Dr. h.c. W. Reichardt.)

NEURAL MECHANISMS OF VISUAL FLIGHT CONTROL IN FLIES:. K. Hausen (Institute of Zoology, University of Cologne, Weyertal 119, 5 Köln 41, Germany).

Visual flight control in flies has been thoroughly studied in the last years. Recent electrophysiological and anatomical investigations in *Calliphora* have focussed, on the one hand, on the neural mechanisms underlying visual course-stabilization, the discrimination and fixation of objects, and the chasing of females displayed by males during courtship. On the other hand, the neural circuitry of the flight motor in the thoracic ganglion has been analysed in detail. Visual course-stabilization is mediated by directionally selective large-field neurons of the lobula plate, which integrate the output signals of extended arrays of retinotopic elementary motion detectors, and which induce compensatory steering manouvres during unvoluntary rotations in flight. Discrimination, fixation and tracking of objects is controlled by a specific subset of directionally selective cells of the lobula plate, which are tuned to small-field motion, and which induce turnings of the flying animal towards moving targets (review: Hausen and Egelhaaf, 1990). In contrast, the chasing behavior of males seems to be controlled by male-specific visual interneurons in the lobula, which respond preferentially to small-field motion in all directions and scan exclusively the dorsofrontal region of the visual field.

All these output cells of the optic lobe are connected via descending neurons to thoracic ganglion, which contains the motoneurons of the power and steering muscles of the wings. Anatomical analyses of the motoneurons of both groups of muscles have revealed that their dendrites are directly postsynaptic to the visual descending neurons but also to mechanosensory afferences from wings, halteres and antennae. In accordance with previous electrophysiological evidence (review: Heide 1983), these anatomical data indicate strongly that the motoneurons of the flight motor are complex multimodal integrators, which process not only the discussed visual information but also mechanosensory information during flight.

CONDITIONED PATTERN DISCRIMINATION IN FIXED FLYING *DROSOPHILA*. Reinhard Wolf and Martin Heisenberg, Theodor-Boveri-Institut für Biowissenschaften der Universität, Lehrstuhl für Genetik, Am Hubland, 8700 Würzburg, F.R.G.

A single fly is stationarily flying in a flight simulator where its momentary yaw torque is made inversely proportional to the angular velocity of its visual surround. The visual surround consists of four equally spaced (90° apart) 'T'-shaped black patterns with every second 'T' turned upside-down. The fly's yaw torque and flight direction with respect to the four patterns are recorded continuously. No spontaneous preference of flight direction for either of the two pattern types can be observed. If the fly is heated by an infrared beam every time it is heading, for example, towards an upright 'T' it quickly learns to avoid holding this pattern in the frontal visual field. In the subsequent test period without any heat, the fly keeps a preference for the same pattern type that previously was not combined with heat. The results of control experiments suggest that indeed the fly is able to visually discriminate both patterns. In addition, promptness and efficiency of learning are substantially improved if the fly is allowed to detect the immediate effect of its flight manoeuvres upon heat (i.e. operant conditioning). With its ability to find (e.g. by cross correlation) among its many motor outputs the single one which influences an arbitrarily chosen input, a fly is best prepared for all eventualities. We have demonstrated that this principle can be recognized in several behavioral activities of *Drosophila*, even in visual course control that as yet was argued to be exemplary for the reflex-like character of insect behavior.

OCELLAR MODULATION OF ORIENTING BEHAVIOUR IN FREE-FLYING HONEYBEES. Kastberger, Gerald (Institute of Zoology, University of Graz, A 8010 Graz, Austria, Europe)

The ocelli are known to play some role in orientation, in flight stabilization, in photokinetic and phototactic behaviour. Recent experiments (KASTBERGER 1990), however, dealing with honeybees on feeding and homing flights, document that the ocelli apparently modulate behaviours also at higher levels. Some of the main features of the ocellar system recently found in honeybees under free flight conditions (flight channels with stationary side lights) can be summarized as follows:

(1) The ocelli determine working points and gains in the orienting subsystems of free-flying bees. This can be found in resonance effects and overdriving occurring in the ocelli-occluded state. (2) The ocelli help the bee to choose the adequate orienting strategy, e.g. whether phototactic or pattern-induced behaviour should be dominant. This can be demonstrated in particular in the fact that the ocelli reduce the degree of the coupling of orienting subsystems making the bee more flexible for orienting decisions. Further (3), the ocelli are likely to modulate processes dealing with object identification. This assumption bases upon the observation that ocelli-occluded bees show a more intense bias in spatial dependence than fully sighted bees (as they are more determined by spatial factors, such as the distance to the object of interest).

CALLING BEHAVIOUR IN BUSHCRICKETS WITH DIFFERENT COMMUNICATION SYSTEMS (Orthoptera, Tettigonioidea, Phaneropteridae). Klaus -Gerhard Heller (Dept. of Zoology II, University of Erlangen - Nürnberg, D-W-8520 Erlangen, Germany)

Acoustic communication in bushcrickets has many functions, e.g. mate attraction and species recognition. Morover, the females may assess the quality of males from their songs. While song structure has been shown to be important in the first two contexts, sound intensity and duration of sound production may be more important in the latter.

In this study the calling activity (in number of syllables) and its timing during the day was analyzed in several species of the genus *Poecilimon* representing two different communication systems. In species with females approaching silently the singing males, males were active only at night and showed high syllable numbers. In species with females responding acoustically to male song and males approaching the females, males were active both during day and night or during day only and exhibited a much lower calling activity. After mating, male acoustic activity dropped to a very low level, but was restored during the following two to three days, a time period longer than the minimal male mating interval.

The observations are discussed with regard to possible energetic limitations, the risks of attracting predators and parasitoids and the costly spermatophore production of males.

ABDOMINO-NEURONAL CONTROL OF ACOUSTIC BEHAVIOUR IN CRICKETS (ORTHOPTERA;GRYLLIDAE). B.J.MILLIGAN (Dept. of Biology, The Open University, Milton Keynes MK7 6AA, U.K), R.BECK (Division of Biological Sciences, Derbyshire College of Higher Education, Derby DE3, U.K).

The abdominal region of the cricket CNS appears to fulfil a bifunctional role in the neural control of acoustic behaviour. Proprioceptive feedback from abdominal peristalsis during the act of spermatophore protrusion exerts a general modulatory influence, serving to elevate the sexual receptivity of the cricket and to prime the song generator network. A more intimate association between the abdominal CNS and the song pattern generator is, however, apparent, and evidence is accumulating to suggest that in Acheta domesticus certain elements of the CPG responsible for sound production extend beyond the thoracico-abdominal boundary.

CNS- Central Nervous System
CPG- Central Pattern Generator

THE PROBLEM OF MATE CHOICE IN BUSH CRICKETS (ORTHOPTERA, TETTIGONIIDAE) David Robinson (Dept. of Biology,.The Open University, Milton Keynes, MK7 6AA, U.K.)

The songs of bush crickets serve to bring the sexes of the same species together for mating. It is implicit in this fact that species recogntion and sound localisation must occur. It has yet to be demonstrated conclusively that bush crickets make substantial use of the song characteristics to chose their mates.

In species where both males and females produce songs there are possibilities for both sexes to make choices based on acoustic information. However, in some of these species the songs are greatly reduced in length and may lack sufficient information carrying ability to act as signals for mate choice, In these species there may be a trade-off between information content and the advantage of short signals.

This paper reviews the current state of knowledge of mate choice and describes acoustic behaviour in a range of species where both males and female sing and the potentiality for mate choice exists.

MORPHOLOGY AND PHYSIOLOGY OF THE COMPLEX TIBIAL ORGANS IN TETTIGONIIDS
Klaus Kalmring, AG Neurobiologie, FB Biologie-Zoologie, Philipps-Universität, D-3550 Marburg, FRG
Comparative investigations of the complex tibial organs of different European bushcrickets have been done; that includes morphological aspects, bioacoustic transduction processes and functional properties of the auditory organs of the forelegs.
So far investigated all bushcrickets have nearly the same audible range altough there are differences in the morphology and the number of receptor cells between the receptor organs of the different species. The audible range lies between 2 and 70 kHz. There seems to be no functional adaptation of the tympanal and intermediate organs to the parameters of the conspecific song. However, comparative studies on the complex tibial organs of different bushcricket species exhibit clear functional adaptations. Frequency weighted activity of the receptor cell population is correlated to the carrier frequency of the corresponding conspecific song. Different propertions of the numbers of low- to high frequency receptors within the organs seem to be the basis for this adaptation originating in different mechanical stimulus transformation conditions.

PRE- AND POSTSYNAPTIC CATION CHANNELS: IN SITU AND RECONSTITUTION STUDIES. Heinz Breer (University Stuttgart-Hohenheim, **D-7000 Stuttgart 70, Germany**)

Activities of the nervous system are controlled by the communication between neurons at specialized structures, the synapses, where electrical and chemical activities of neurons are interlinked. The precisely regulated release of transmitter molecules is initiated by an influx of Ca^{2+}-ions via presynaptic voltage-gated ion channels. The rapid kinetics of the evoked calcium signals in isolated nerve terminals have been monitored by stopped-flow spectrofluorimetry using specific indicators (e.g. Fluo-3). Upon application of novel fusion techniques 'giant synaptosomes' were produced providing a basis for the application of patch-clamp approaches to study presynaptic ion channels.

Rather high concentrations of receptors for acetylcholine have been detected in the nervous system of insects, predominantly of the nicotinic type. Receptor proteins, which bind α-toxins have been isolated and purified. After reconstituting the receptor protein into planar lipid bilayer the channel properties of this neuronal nicotinic acetylcholine receptor have been elucidated.

COMPUTERIZED STUDIES OF LEG-POSITION LEARNING IN THE COCKROACH *Periplaneta americana* (L). C. Leon Harris (Department of Biological Sciences, State University of New York, Plattsburgh, 12901, USA.)

In 1962 G. A. Horridge described a simple technique for leg-position learning in insects that has been widely used in studies of the neurophysiology and pharmacology of learning. During training, legs of two insects, called P and R, are wired in series with an electrical stimulator, and P is able to interrupt the electrical stimulation by lifting the leg. R is unable to stop the stimulation, and is therefore a yoked control that is shocked whenever P is. For testing, both P and R are individually able to avoid shock by lifting the leg, and P is judged to have learned if it receives fewer shocks than R. This technique has been criticized because the legs make unconditioned as well as conditioned responses to shocks, and there can be bias in repositioning R for testing. Some researchers have therefore questioned whether the Horridge technique is capable of demonstrating learning.

I describe a device that avoids these problems by allowing a variety of stimuli to be applied anywhere on the insect to train it to either lift or to lower the leg, without repositioning for testing. Insects can also be tested not only for the trained task (such as lifting the leg) but also for reversal (avoiding leg lifting after training). In addition, results can be stored and analyzed automatically by a personal computer.

With this device, cockroaches learned to lift a mesothoracic leg to avoid shock to the opposite prothoracic leg. P cockroaches received fewer shocks than did R during testing, and they received many more shocks during reversal. Cockroaches could not, however, learn to lower a mesothoracic leg to avoid shock to the opposite prothoracic leg. Results will also be described for studies in which light was used as the conditioning stimulus.

Subtypes of ligand-gated ion channels on identified insect neurones

D. Bai and D.B. Sattelle (AFRC Laboratory of Molecular Signalling, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, U.K.)

Physiological and pharmacological studies on vertebrate and invertebrate neurotransmitter receptors have revealed the existence of multiple receptor subtypes for a particular neurotransmitter molecule. Investigations on the functions of particular receptor subtypes would be facilitated by studies on neurones of known function.

Nervous systems of invertebrates can provide ready access to identifiable cells and pathways. Thus, it should be possible to examine whether or not neurotransmitter-gated ion channel subtypes are associated with functionally-distinct neurones. Studies have been performed on identified motor neurone, interneurones and sensory neurones, together with dorsal midline (DM) cells containing neuromodulator cells in the nervous system of the cockroach *Periplaneta americana.*

GENETIC STUDIES OF ION CHANNELS IN *Drosophila*. Chun-Fang Wu (Department of Biology, University of Iowa, Iowa City, Iowa 52242, U.S.A.)

One way to investigate mechanisms of neuronal activity is to study single-gene mutations that affect individual currents in *Drosophila.* We used "giant" *Drosophila* neurons, derived from cell-division arrested neuroblasts, to examine effects of mutations on neuronal currents by correlating voltage- and current-clamp results in the same cell. We have observed in these neurons Na and Ca inward currents, and K outward currents, i.e. voltage-activated I_A and I_K and Ca-dependent $I_{K,Ca}$. In addition, we found a persistent Na current ($I_{Na,P}$) and a TTX-sensitive, Na-dependent K current ($I_{K,Na}$). I_A controls inter-spike intervals and delays action potential initiation. Manipulating I_A inactivation by changing resting potential did not alter action potential durations in wild-type neurons. But the same manipulation broadened spike duration in neurons from *slowpoke*, a mutant with defective $I_{K,Ca}$. This confirms that both I_A and $I_{K,Ca}$ contribute to action potential repolarization. The role of $I_{Na,P}$ and $I_{K,Na}$ in the regulation of spike discharge pattern has been analyzed in mutants with defective Na currents and by ion replacement experiments.

A variety of K channels contribute to the diverse signalling capacity of excitable cells. Previous studies show that several distinct K currents in *Drosophila* muscle are separately affected by mutations of different genes. Mutations of the *ether a go-go* (*eag*) gene caused allele-dependent defects in all identified K channels in *Drosophila* muscles, i.e., the voltage-activated I_A and I_K and the Ca-activated I_{CF} and I_{CS}. This observation raised the possibility the the *eag* gene contributes a subunit common to different K channels. Indeed, recent molecular analysis shows that the *eag* gene defines a putative K channel polypeptide distinct from the I_A channel proteins encoded by the *Shaker* locus. The null phenotype observed in the *eag* mutations and the fact that it could be mimicked by pharmacological agents affecting second messenger cascades suggest that *eag* mutations disrupt channel modulation. The results also support the idea that a combinatorial assembly of different polypeptides contributes to K channels diversity.

CLONING SEQUENCING AND FUNCTIONAL EXPRESSION OF LIGAND-GATED ION CHANNELS

D.B. Sattelle, J. Marshall, K.W.P. Miller, J.B. Harrison (AFRC Laboratory of Molecular Signalling, Department of Zoology, Cambridge CB2 3EJ, UK),
J.J. Rauh, J.F.H. Wong (E I du Pont de Nemours, Stine-Haskell Research Center, Newark, DE 19714, USA)

The cloning sequencing and functional expression of an α-subunit of a locust (*Schistocerca gregaria*) nicotinic acetylcholine receptor has been described.[1] Injection into *Xenopus* oocytes of RNA synthesized from this clone *in vitro* resulted in the expression of functional nicotinic receptors in the oocyte membrane. Nicotine gated a cationic channel that was blocked by α-bungarotoxin. Reversible block of the expressed nicotinic receptor by mecamylamine, d-tubocurarine, tetraethylammonium and bicuculline was also observed. Thus, a functional receptor mimicking many of the properties of an *in situ* insect nicotinic receptor (including sensitivity to nitromethylene insecticides [2]) was expressed in *Xenopus* oocytes by injection of a single receptor subunit RNA.

Recently, similar experimental approaches have been adopted to the cloning, sequencing and functional expression of *Drosophila melanogaster* GABA receptor subunits. Synthetic oligonucleotides based on highly-conserved transmembrane regions have been employed to probe a *Drosophila* λ ZAP cDNA library. A clone containing a β-like subunit has been isolated and sequenced, as a prelude to functional expression studies.

[1]Marshall et al (1991) EMBO J. 9, 4391-4398.
[2]Leech et al (1991) FEBS Lett 290, 90-94.

OLFACTORY CODING AT THE PERIPHERAL LEVEL IN WORKER HONEY BEES. Wayne M. Getz, R. Patrick Akers (Department of Entomology, University of California, Berkeley, CA 94720, USA).

In contrast to employing specialist receptors and 'labeled lines' to code pheromonal stimuli, insects employ generalist receptors and across fibres patterns to code environmental olfactory signals, as well as kin recognition cues in the case of social insects. Here we present data from neurophysiological recordings made extracellularly at placodes on the antennae of honey bee workers. The multiunit placode responses are to selected compounds in various combinations and at several concentrations. We sorted spikes into subplacode response classes, using SAPID TOOLS. We then used principle components and cluster analyses to categorize placodes and subplacode units into response types. We also identified linear and nonlinear aspects of peripheral responses with respect to concentration, mixtures, and temporal coding as a function of compound type (aldehydes, alcohols, pheromonal components). We interpret the results in terms of behavioral data relating to olfactory perception and learning in honey bees.

MECHANISMS OF MUSCLE PATTERNING DURING DEVELOPMENT IN DROSOPHILA. Michael Bate (Department of Zoology, Downing Street, Cambridge CB2 3EJ England.)

Muscles in the fly are syncytial, striated and similar to those in vertebrates. In the late embryo the muscles form a complex pattern of birefringent fibres on the epidermis which allows us to screen for muscle defective mutants with a polarising microscope. We have shown that muscle assembly involves a sequence of steps in which cells fuse to form precursors at specific sites in the mesoderm closely applied to the ectoderm. The decisive event in muscle formation appears to be the specification of a mesodermal *founder cell* for each of the future muscles. Founder cells fuse with adjacent *fusion competent cells* to form a muscle precursor and this syncytium then puts out growth cones which navigate to specific epidermal insertion sites. We have also shown that the Drosophila homologue of vertebrate MyoD genes, *nautilus*, is mesodermally expressed, confined to small clusters of cells and that the onset of *nau* expression correlates with the formation of binucleate muscle precursors. The onset of muscle specific gene expression also coincides with a decline in the mesodermal expression of *twist*. However, *twist* expression persists in a small, highly consistent set of cells in every segment. We have shown that these cells are the embryonic precursors of the adult muscles. *twist* expression persists in these cells into larval life and they proliferate, forming pools of adult myoblasts. In the embryo, the adult myoblasts are associated with the primordia of the imaginal discs and with parts of the peripheral nervous system in the abdomen. Thus, about one third of the way through embryogenesis, two patterns of muscle forming cells segregate from the embryonic mesoderm: larval precursors characterised by cell fusion and the onset of muscle specific gene expression; and adult muscle precursors characterised by persistent *twist* expression and the capacity for further division. Mechanisms which lead to the segregation of these two patterns will be discussed.

SYNAPTOGENESIS AND SYNAPTIC TURNOVER: THE FINAL TOUCHES TO THE FINISHED NERVOUS SYSTEM. I.A. Meinertzhagen (Life Sciences Centre, Dalhousie University, Halifax, Nova Scotia, Canada B3H 4J1)

Early events in insect neurogenesis are consummated when a neuron establishes synaptic contacts with prospective targets. Synaptogenesis persists into adulthood as turnover and as final adjustments amongst synaptic circuits. These have been studied in two synapses of the lamina of the fly's (*Musca domestica*) optic lobe. Terminals of photoreceptors R1-R6 are repeatedly presynaptic at afferent tetrad synapses which comprise postsynaptic elements from lamina monopolar cells L1 and L2, as well as two amacrine cell processes. L2 in turn feeds back at dyad synapses, upon R1-R6 and a process of a medulla cell, T1. Both synapses in any fly are of fixed size and composition. Their numbers are closely regulated but both show a decline with age. The numbers also vary with visual experience received, especially soon after eclosion. With light, tetrad numbers are increased and feedback numbers decreased. The changes are rapid among tetrads, and sensitive among feedbacks, and give rise to antiphase circadian changes in the two populations. With 2-d periods of differential experience, the number of feedback synapses behind a seeing eye is 30% less than behind a dark-reared one, with evidence of a critical period during the first 4d post-eclosion. After receptor cell photo-ablation, R1-R6 degenerate, provoking dramatic evidence of plasticity in L1 and L2. With loss of presynaptic ribbons, tetrad sites rapidly disassemble, postsynaptic dendrites retracting as an ensemble. L2 feedback sites disappear, with the ribbon invaginating into L2's cytoplasm. New sites form concurrently by reactive synaptogenesis between L2 and T1, indicating the fly's capacity to re-enact programmes for synaptogenesis first expressed in its pupa. Invaginated floating ribbons also occur in non-degenerated cartridges, where they reflect a normal process of synaptic loss. The dynamics of such loss have been examined after 30% of tetrads disappear, when flies are exposed to 0°C for 24hrs. On recovery at 23°C, tetrad number reversibly returns to normal, with a rapid time constant. These changes indicate a capacity for rapid rates of synaptic gains and losses in adult flies, even though normal net rates of change are slow.

ENDOCRINE APPROACHES FOR EXAMINING THE DEVELOPMENT OF THE INSECT CNS. James W. Truman, Department of Zoology, University of Washington, Seattle WA 98195 USA.

During metamorphosis ecdysteroids cause diverse responses in the insect CNS, including maturation of adult-specific neurons, remodeling of larval neurons, and programmed neuronal death. The talk will focus on the last two processes, neuronal remodeling and programmed cell death, describing the changes that occur in selected motoneurons during metamorphosis and the role of ecdysteroids in evoking these changes. The pattern of expression of ecdysteroid receptors (EcR) provides a key to understanding the regulation of these changes. The recent isolation of the EcR gene from Drosophila (Koelle, et al., 1991 Cell **67**:59; Talbot & Hogness, unpublished) revealed that there are 3 forms of the receptor. Examination of the pattern of EcR expression in both Drosophila and Manduca sexta shows that the pattern of receptor expression varies though metamorphosis and also according to cellular fate and brain region. The expression patterns suggest that different cell fates as well as quantitative aspects of neuronal development may be encoded in the patterns of EcR expression. The significance of these correlations will be discussed.

A STUDY OF THE MECHANISM OF SPERM PENETRATION THROUGH THE TESTICULAR CALYX SEPTA (TCS) IN A LEPIDOPTERAN MOTH, THE BEET ARMY WORM, *SPODOPTERA EXIGUA*. Amaldoss G.(Department of Ecology, Evolution, and Organismal Biology, 2000 Percival Stern Hall, Tulane University, New Orleans, LA 70118, USA),**Chen Chuan-Shang**(Department of Biology, Fu Jen Catholic University, Taipei, Taiwan, China), **Liu Chi-Feng**(National Taiwan Medical Center, 25 lane 24 Roosevet Rd Sect 4, Taipei, Taiwan, China), **Fingerman M.** (Department of Ecology, Evolution, and Organismal Biology, 2000 Percival Stern Hall, Tulane University, New Orleans, LA 70118, USA)

Many studies have been done on testicular development and the spermatozoa of lepidopterans. However studies on the mechanism of sperm penetration through the TCS have been limited to a very few species. The sperm entry mechanism has been studied in our laboratory by means of serial histological technique. The posterior portion of each sperm bundle folds back itself to form a U shaped structure. The entire structure approaches the septum with the U directed facing the septum. As a sperm bundle approaches the TCS, septal cells that have large nucleus appear to engulf the sperm bundle by use of pseudopodial processes. The sperm bundle then unfolds and emerges on the proximal side of the septum, tail first, leaving the cellular cyst wall to be digested by the septa.

COMBINED EFFECTS OF GAMMA RADIATION AND SOME PHYSICAL FACTORS ON THE FEMALE FECUNDITY AND EGG HATCHABILITY OF *CULEX PIPIENS* COMPLEX (L.). Mahmoud Hafez (Entomology Department, Faculty of Science, Cairo University, Giza, Egypt), A.M. Wakid (Atomic Energy Authority, Egypt), A. M. Abedel-Rahman (Faculty of Science, Cairo University, Egypt) and M.K. Hafez (Academy of Scientific Research, Cairo, Egypt)

The role of some physical factors applied, separately or combined with gamma radiation on female fecundity and egg hatchability of *Culex pipiens* was studied. The results indicated that the use of gamma radiation (60Gy), oxygen, partial vacuum (0.1 torr), low temperature (10°C) or 31% relative humidity alone resulted in great decrease in female egg production which continued when the use of these factors was followed by irradiation with 60 gray of gamma radiation and egg laying was inhibited. Exposure of pupae to gamma radiation alone or combined with oxygen, partial vacuum, low temperature or 31% relative humidity, drastically affected egg hatchability of the produced adults. The same effect was observed when any of the studied factors was applied separately. However, a less but significant effect was recorded when applying oxygen gas alone.

INTERSPECIFIC VARIATIONS IN BIOENERGETIC ENDOCRINOLOGY OF OVARIAN MATURATION IN TWO NOCTUIDS. M.T.El-Ibrashy (Plant Protection Department, National Research Centre, Dokki, Cairo 12622, Egypt)

The present report deals with study of the energetics of ovarian maturation in causal correlation with corpus allatum (CA) endocrine regulatory functions all along the whole sequence of larval-pupal-adult developmental events in two closely related, albeit physiologically different, noctuids, viz. Spodoptera littoralis (Boisd.) and Scotia ipsilon (Hufn.).The former insect was selected as a model system for 'pre-metabolic' Lepidoptera in the sense that ovarian maturation is fully complemented prior to adult eclosion, whereas the latter insect represents the 'post-metabolic' Lepidoptera whose eclosing adults undergo such maturation immediately after eclosion. For both the model systems, all the energy data presented were obtained by the method of indirect calorimetry, as based essentially on manometric measurements of the gaseous exchange rates and evaluation of both the calorific and respiratory quotient mean values. Besides elucidation of several interspecific variations, as detailed in the report, it can be concluded however that the carbohydrates—in both species grossly alike—are of potential importance as they form the main source not only for energy yield but also for endergonic conversion to fat.Implications are made of the possible CA regulatory role in such developmental phenomena, of which the ovarian maturation is the final phase.

DEVELOPMENTAL DERANGEMENTS IN MALE REPRODUCTIVE SYSTEM AND SPERMATOGENESIS IN JUVENOID AND PRECOCENE II TREATED *Nezara viridula* (Linn.) (HETEROPTERA : PENTATOMIDAE). Biplab Mukhopadhyay (Kanchrapara College, Kanchrapara, India, 743145), S. Chakravorty (Department of Zoology, University of Kalyani, India, 741 235).

Different types of developmentally intermediate forms such as super nymph, adultoid larva, imperfectly moulted adultoid, perfectly moulted adultoid and externally normal adult are produced after juvenoids hydroprene (ZR-0512), methoprene (ZR-0515) and SJ-53-Fch and anti-hormone precocene-II treatments to 0-24 hr old last nymphal instar of the Green stink bug, *Nezara viridula* (Linn.) at the rates of 100 ug and 10 ug per individual. Juvenoids and precocene-II produce some common developmental derangements in the anatomy and morphometry of male reproductive system and histoarchitecture of testes of intermediates, and these are : testis size asymmetrical and reduced; length of vas deferens and accessory reproductive organs reduced and, testicular cyst population decreased. Abnormalities typical of intermediate forms are : disintegration of cysts which lost their identity in super nymph, loosely arranged cysts in imperfectly moulted adultoid and deformed sperm bundles, sometimes giant in size, in imperfectly moulted adultoid. Precocene-II shows necrosis of cellular components of testis in the precociously moulted adultoid larva. However, most of the present findings indicate the possibility of male sterility.

HOUSEFLY OOSTATIC HORMONE - FACT OR FICTION. **T.S. Adams (USDA-ARS Biosciences Research Laboratory, Fargo, ND 58105, USA)**

The oostatic hormone was described 24 years ago as an ovarian feed back mechanism that inhibited the neuroendocrine system to give cyclical egg development. Recently, we have shown the both ecdysteroid and vitellogenin titres cycle during oogenesis with the highest levels occurring during mid-vitellogenesis. Low vitellogenin and ecdysteroid levels are found during post-vitellogenesis. By the time the first cycle follicles reach stage 10 the second cycle follicles are at stage 3 or 4. Since vitellogenin levels are low, development of the second cycle will not proceed past stage 4. After oviposition of the first cycle of eggs, ecdysteroid and vitellogenin levels increase and the second cycle of follicles mature. Immediately after oviposition, the flies will engorge on the ovipositional medium or protein diet. If the flies were prevented from feeding on protein after oviposition and given only carbohydrate, ecdysteroid and vitellogenin levels did not increase and follicle development remained at stage 4. Thus oviposition, ie. removal of the oostatic hormone, is not responsible for cyclical ovarian development but feeding on protein is.

***IN VITRO* AND *IN VIVO* DIFFERENTIATION OF MALE GERM CELLS IN LOCUST, *LOCUSTA MIGRATORIA MANILENSIS*.** **Jian Wang, Xiang-chen Zhong** (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Testicular follicles from day 3 4th instar locust cultured in TC199 or GRACE media were arrested at spermatocyte-I. Addition of 10%FBS or locust testis homogenate could promote development to spermatocyte-II. Applications of Precocene-I and 20-hydroxyecdysone (20-E) with or without the presence of fat body or locust brain in media had no detectable effects on their development. While cultured in media with 10% hemolymph from either *L. migratoria, A. pernyi or P. cynthia,* the follicles developed with a massive production of spermatids and sperms. Application of 20-E and JH-I had no effect on the development in latter case. Testicular follicles of day 3 3rd instar, day 3 4th instar and day 0 5th instar implanted into male or female adult locusts ceased development, which was promptly recovered by injection of 20-E. By implantation, intact testis could proceed spermatogenesis and produce sperms spontaneouly within 8 days without injection of ecdysone. These results indicate that the insect hemolymph contain factor(s) that can promote the differentiation of spermatid and spermatogenesis; the factor(s) seens to be non-species specific; the effect of ecdysteroid might not be direct; spermatogenesis and normal differentiation of spermatid need both ecdysteroid and hemolymph factor(s); and the intact testis might has its own source of ecdysone.

THE EFFECTS OF PRECOCENE II ON THE VITELLOGENESIS OF THE HOUSE-FLY, MUSCA DOMESTCA. Qian-jun Li, Zhi-he Guan (Beijing Agricultural University) He Gong (Institute of Zoology, CAS)

Observation on the development of overies, hormone treatment, quantitative analysis of soluable protein and nucleic acid, and vitellogenin titer measurment in hemolymph using rocket immuno-electrophoresis, precocene II inhibition on the vitellogenesis of housefly were reported. When the newly emerged female houseflies were treated with precocene II 20ug/fly, the vitellogenesis of the housefly was temporary-inhibited, the vitellogenesis appeared 12 hours later then that in control; 48 hours after treatment, the titer of vitellogenin in hemolymph was 10.5 ug/ul, nearly the same as those in control. this temporaty-inhibiting condition revealed that the uptake of vitellogenin by oocyte was almost wholely inhibited. When treated with high dose, 100ug/fly, the titer of vitellogenin in hemolymph and the wight of overies are obviously lower than that in control. The development of the overies were also obviously inhibited. The inhibition could be restored naturally.

When precocene II was applied together with JH III, the vitellogenesis could not be inhibited, the titer of vitellogenin in hemolymph was two times that in temporary inhibited flies. When precocene II was applied together with 20-hydroxy-ecdysone, the vitellogenesis was still inhibited. In the end, the mode of action of precocene on dipteran insects was discussed.

HORMONAL REGULATION OF HEMOLYMPH JUVENILE HORMONE BINDING PROTEIN IN *Manduca sexta*. Walter G. Goodman, Purnama Hidyat, Yong Chul Park, Michael Tesch and Yeon-Soo Han (Dept. of Entomology, University of Wisconsin, Madison, WI 53706, USA)

The hemolymph of many lepidopterans includes a specific, high affinity, low molecular weight juvenile hormone binding protein (JHBP). During certain stages of development in *Manduca sexta*, virtually all JH is associated with the hemolymph protein. Given this large buffering component between the site of synthesis and the site of action, the protein must play an important role in communication between these sites. We surveyed JHBP and JH titers during specific developmental stages and examined the effects of endocrine manipulation. JHBP and JH titers were determined by enzymeimmunoassay and radioimmunoassay respectively.

JHBP titers during the fourth stadium fluctuate more dramatically than previously reported. The lowest JHBP titer of the fourth stadium, 12 hours post ecdysis, corresponds with the highest JH titer. Conversely, the highest JHBP titer, 60 hours post ecdysis, corresponds with low JH titers. The same pattern is seen during the feeding stage of the fifth stadium. After wandering, this pattern changes and JH seems to have a stimulatory effect on JHBP titers. Male and female titers are significantly different during this period and may reflect the dimorphism seen in JH titers. Males display a reduced JHBP titer. Sexual dimorphism in JHBP titers is also displayed during the pupal stage. Females generally display the highest titers. Addition of analogs or the natually occurring hormones seems to decrease the titers of JHBP during the feeding stages, while topical application of JH to wandering animals results in an increase in JHBP titers. In addition, hemolymph JHBP levels may be regulated by other factors.

HORMONAL CONTROL OF REPRODUCTION IN THREE SPECIES OF LOCUSTS. Takashi Okuda, Seiji Tanaka (Department of Insect Physiology and Behavior, National Institute of Sericultural and Entomological Science, 1-2 Ohwashi, Tsukuba, Ibaraki, Japan 305)

The ovarian maturation was under the control of photoperiod in the three species of locusts, Locusta migratoria manilensis, Nomadacris succincta and Nomadacris japonica, i.e. the pre-oviposition period was prolonged when locusts were reared under long day conditions in L. migratoria, and imaginal diapause was induced under any constant photoperiod in N. succincta and N. japonica. To understand the hormonal regulation of the reproduction in the these locusts, we examined juvenile hormone (JH) biosynthesis by corpora allata (CA) in vitro and JH esterase activity in the hemolymph in relation to the ovarian development.

We also looked at the effects of Precocene II and a JH analogue (ZR515) on CA activity and oogenesis at different photoperiods in the three species. L. migratoria under long day conditions could respond to ZR515 by maturing eggs. Application of several doses of ZR515 to diapausing N. succincta and N. japonica did not induce any sign of ovarian development.

JUVENILE HORMONE BINDING PROTEIN IN OVARIES OF HOUSEFLY MUSCA DOMESTICA. Wen-hui Zheng, He Gong (Institute of Zoology, Academia Sinica, Beijing 100080, China)

By using charcoal binding assay, the juvenile hormone binding protein (JHBP) in the ovaries from housefly and the fluctuation of its activity during the first gonotrophic cycle had been identified. This binding protein possessed a high affinity for juvenile hormone III and had an equilibrium disasociation constant of 2.1×10 M for juvenile hormone III. The binding reaction of tritium juvenile hormone III to this JHBP was competitively inhibited by unlabled juvenile hormone III, but not by juvenile hormone analog, ZR512 or ZR515. The activity of juvenile hormone binding protein was the highest in the ovaries from housefly at 48 hr.after emergence and was 6.5 and 15.5 fold higher than that of the ovaries from housefly at 60 hr.and 72 hr.after emergence, respectively. The ovaries from housefly 24 hr or 36 hr after emergence had no detectable binding activity. The data indicated that the ovarian juvenile hormone binding protein was associated with juvenile hormone action in vitellogenin uptake by the ovaries.

PROTHORACICOTROPIC ACTIVITY IN THE BRAIN OF THE COCKROACH *Periplaneta americana* . Klaus Richter (Saxon Academy of Sciences, Research Group Jena, D-6900 Jena, PB322, Germany)

Co-incubation experiments of moulting glands with whole brains and crude brain extracts respectively, were performed and analysed by ecdysone RIA to determine the prothoracicotropic activity in the brain of the cockroach *Periplaneta americana*. Two periods of prothoracicotropic activity in the brain of last instar larvae, related to a characteristic transient increase of ecdysone production of prothoracic glands in vitro were demonstrated. Prior to the first ecdysone peak of the moulting gland on the 23rd day, the first major peak of prothoracicotropic activity of the brain occurred on the 21st day in co-incubations with whole brains. A second peak was present at the end of the larval instar about the 30th day, parallel to the main ecdysone peak. The increase in ecdysone production was in both periods about 40%, in co-incubations with crude brain extracts between 60% and 100%. Even the brain of imagines, at least up to the 10th day after imaginal moult, has prothoracicotropic activity to a certain degree, i.e. 2/3 of the brain activity during the major peaks of the larval instar.

ISOLATION AND CHARACTERIZATION OF A PHEROMONOTROPIC NEUROPEPTIDE FROM THE ARMYWORM LARVAE, PSEUDALETIA SEPARATA. S. Matsumoto, A. Fonagy, M. Kurihara, K. Uchiumi, T. Nagamine, and T. Mitsui (Institute of Physical and Chemical Research, Wako, Saitama 351-01, Japan)

A novel pheromonotropic neuropeptide has been isolated from a head extract of the armyworm larvae, Pseudaletia(=Leucania) separata, by a seven-step purification procedure using an in vivo assay with decapitated female moths of Bombyx mori. Amino acid sequence analysis and comparison with synthetic peptides established the primary structure of the peptide, termed Pseudaletia pheromonotropin (Pss-PT); Pss-PT is an amidated 18 amino acid peptide possessing a C-terminal pentapeptide, Phe-Thr-Pro-Arg-Leu-NH2.

Bioassay of synthetic peptides has revealed that Pss PT also has a melanization and reddish coloration hormone (MRCH) activity, which regulates morphological color change of the armyworms associated with phase polymorphisms or with specific developmental stages, and the MRCH activity resides in the C-terminal pentapeptide.

FMRFamide-LIKE IMMUNOREACTIVITY IN THE VENTRAL NERECORD OF THE LARVAL SPRUCE BUDWORM.
P. Sivasubramanian, Dept. of Biology, Univ. of New Brunswick, Fredericton, N.B. CANADA E3B 6E1.

The cardioexcitatory neuropeptide FMRFamide is widely distributed in most animal groups including insects. Since insect neuropeptides are considered as potential target sites for pest control, the distribution of FMRFamide-like immunoreactivity was examined in the ventral nerve cord of the larva of the eastern spruce budworm, Choristoneura fumiferana, a major forest pest in Atlantic Canada. In each ganglion three groups of neurons exhibit positive immunoreactivity. These neurons are distributed in a bilaterally symmetrical fashion at the antero-dorsal, mid-lateral and postero-ventral regions of the ganglia. There are four immunoreactive fiber tracts on the dorsal surface of the ganglia to which the antero-dorsal neurons project ipsilaterally, while the mid-lateral pair project both ipsi-, and contralaterally. The terminal abdominal ganglion has four additional pairs immunoreactive neurons and some of these extend axons into the median abdominal nerve suggesting some role for this neuropeptide in the control posterior structures of the larva.

IMMUNOCYTOCHEMICAL LOCALIZATION OF LEUCOKININ-LIKE PEPTIDES IN *NAUPHOETA CINEREA, AEDES AEGYPTI* AND *MANDUCA SEXTA*. Yuetian Chen, Jan A. Veenstra and Henry H. Hagedorn. (Department of Entomology, University of Arizona,Tucson,A.Z.85721,U.S.A.)

Antisera against leucokinin IV were used to test immunocytochemically the existence of leucokinin-like peptides in the central nervous system of *Nauphoeta cinerae, Aedes aegypti* and *Manduca sexta*. Leucokinin-like immunoreactivity is found in all three species, and the distribution of the leucokinin-like immunoreactive neurosecretory cells is similar in these insects They all have a group of medial neurosecretory cells and a group of lateral neurosecretory cells in the brain, as well as paired neurosecretory cells in each abdominal ganglion. However, the number of cells is different from one species to another. Both abdominal nerves and the corpora cardiaca appear to serve as neurohaemal release sites for the peptide into the hemolymph.

IMMUNOCYTOCHEMICAL EVIDENCE FOR THE PRESENCE OF NEUROSECRETORY CELLS PRODUCING SOMATOSTATIN IN CASTORSEMILOOPER, ACHAEA JANATA

D. Muraleedharan & D. Sheela Devi (Department of Zoology University of Kerala Kariavattom - 695581 India)

Immunocytochemical staining using Peroxidase-antiperoxidase (PAP) technique demonstrated the presence of neurosecretory cells (NSC) secreting stomatostatin-like peptides in the fifth instar larvae of Castor semilooper Achaea janata Linn. (Lepidoptera:Noctuidae) which cross reacted with human somatostatin. These immunoreactive cells were 3-6 in number present superficially at the pars intercerebralis region of brain The approximate diameter of these cells varied from 20 23 u. Another group of similar immunoreactive cells could be located outside the pars intercerebralis region as well. The observation substantiate the hypothesis that neuronal GEP-hormonal production in the brain is a genuinely original mechanism in evolution. The details of the data may be discussed in the light of available literature.

A STUDY ON LYSOZYME IN THE HEMOLYMPH OF *LEUCANIA SEPARATA* AND *OSTRINIA FURNACALIS*. Bao-ling Cai, Zhen-heng Cheng (Biology Department, Nankai University, Tianjin 300071, China)

Larvae of *Leucania separata* and *Ostrinia furnacalis* were immunized by injection of $1x10^7$ *Bacillus thuringiensis* subsp. *kurstaki* or *Escherichia coli*. The insects were held at $25\pm1^{o}C$ for varying times, bled every another 8 hours, using both nephelometry and inhibition zone assay methods for humoral lysozyme activity determination. The lysozyme activities were present in low levels in normal larvae hemolymph of both species,and the induced lysozyme increased quickly at about 24 hours following injection, then remained in higher level until 56 hours of the test intervals. Lysozyme from the immune hemolymph of *L.separata* larvae has been purified using a two-step procedure of column with CM-Sepharose. Each mouse was injected with predetermined lethal dose of approximately $1.4x10^8$ *Enterobacter cloacae*. One hour later, the treated group mice received intraperitoneal injection of 0.4ml purified lysozyme, and the controls received the same dose of saline. The results showed that treated group had lower mortality rates (6 died from 14 tested mice) compared with controls (12 out of 15).

THE AEDES ALBOPICTUS RIBOSOMAL PROTEIN RPL8 GENE HAS A LARGE INTRON IN THE NONTRANSLATED LEADER SEQUENCE. Que Lan, Ann M. Fallon (Department of Entomology, University of Minnesota, St. Paul, MN 55108, USA)

The ribosomal protein rpL8 gene has been cloned from an Aedes albopictus (mosquito) sub-genomic library. The gene codes for the 28,570 Da rpL8 protein from the large subunit, and the estimated pK' is 3.34. The transcription initiation site is 85 nt upstream from translation start codon. There is no TATA box in the regulatory region. The rpL8 gene has two introns and two exons. The first intron is 293 nt long and is located in the nontranslated leader sequence. The second intron is 65nt long and occurs near the end of 5' translated region. The large intron in the nontranslated leader sequence is the first example in sequenced mosquito protein genes. Expression of ribosomal protein genes is important during insect reproduction. The rpL8 gene could be used in transfected mosquito cells to examine molecular regulation of ribosome synthesis.

NUCLEAR PROTEINS THAT INTERACT WITH THE PROMOTER REGION OF A MAJOR PLASMA PROTEIN GENE OF BOMBYX MORI. S. Mori, S. Izumi and S. Tomino (Department of Biology, Tokyo Metropolitan University, Hachioji, Tokyo 19203, Japan)

In Bombyx mori, a family of hormone-sensitive genes encodes major plasma proteins, termed as "30K proteins". To study mechanisms underlying the stage-specific expression of 30K protein genes, the fat body nuclear proteins were analyzed for binding the promoter region of a 30K protein gene (6G1 gene) in the family.

The DNase foot-printing and gel retardation analyses suggested that several sites in the promoter region of 6G1 gene interact with the fat body nuclear proteins. One of these sites (Site-A) contains the sequence homologous to cAMP-responsive element and ecdysone-responsive element. Heparin-agarose chromatography of the fat body nuclear extracts from the fourth and fifth instar larvae revealed the occurrence of stage-specific factors that interact with Site-A. Glycoprotein factors with N-acetylglucosamine moieties interact with the region including TATA-box sequence. Based on these results, possible mechanisms of the 30K protein gene transcription in B. mori will be discussed.

ECDYSONE-RESPONSIVE GENES IN *DROSOPHILA* IMAGINAL DISCS, James W. Fristrom, R. Abu-Shumays, R. T. Apple, C. Bayer, A. Hammonds, D. Fristrom, J. Garbe, J. Moore, S. Paine-Saunders, M. Prout, D. Withers (Department of Molecular and Cell Biology, University of California, Berkeley, CA 94720 U.S.A.) J. Natzle (Department of Zoology. University of California, Davis, CA 95616 U.S.A.)

Ecdysteroids are essential for the morphogenesis and differentiation of imaginal discs during metamorphosis in *Drosophila melanogaster*. The response of ten cloned genes to 20-hydroxyecdysone has been studied in imaginal discs cultured *in vitro*. Based on their times of expression and the nature of their encoded products, these genes fall into five classes: 1. An "early-ecdysone" regulatory gene (*Broad-Complex)* that is essential for metamorphosis has increased expression within one hour of exposure of discs to 20-hydroxyecdysone *in vitro*. This gene produces by differential splicing of RNA a family of DNA-binding proteins each of which contains one of at least three zinc-finger domains. 2. Three "early" genes that encode extracellular components are expressed within an hour of exposure of discs to the steroid hormone. 3. An "early-late" gene that encodes a member of the immunoglobulin super gene family is expressed rapidly at low levels and several hours later at high levels in response to the steroid hormone. 4. Two "late" genes one of which encodes lactate dehydrogenase are expressed only after six to eight hours of exposure to 20-hydroxyecdysone. 5. Three "prepupal" genes that encode pupal cuticle proteins are expressed only after steroid hormone withdrawal . The hierarchical temporal regulation and function of these genes in imaginal disc development will be discussed.

THE HEAT SHOCK RESPONSE OF THE CONIFEROPHAGOUS SPRUCE BUDWORM: PRESENCE OF A NOVEL 77 kDa MAJOR HEAT SHOCK PROTEIN. Robert M. Tanguay, Timothy W. Blaker and Raquel Marin. (Insect Biotech Canada and Laboratoire de Génétique Cellulaire et Moléculaire, Centre de Recherches du CHUL, Ste-Foy, Qc., G1V 4G2 CANADA).

Spruce budworm *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae) is a conifer-feeding insect that develops periodic outbreaks and causes considerable tree mortality. Among the numerous factors that affect budworm populations, fluctuations of the temperature regime may play an important role in this insect's survival and development.

To gain insight on the different stress responses of *Choristoneura fumiferana*, we have studied the heat shock response of an established cell line (line CF_1) by exposing cells to different temperatures (35, 37, 39°C) followed by labelling with ^{35}S-methionine at their normal growth temperature (23°C). Proteins were analysed by SDS-PAGE, two-dimensional gel electrophoresis and by immunoblotting with antibodies made against the hsps of *Drosophila melanogaster*. Apart from the highly conserved hsp 89 and 70, CF_1 cells have a major hsp (77 kDa) that is not seen in dipterans. On 2-D gels, hsp 77 is shown to consist of at least four distinct isoforms. An equivalent hsp 77 is shown to be present in heat-shocked cells from the lepidopteran *Spodoptera frugiperda* (SF9 cells). The 77-kDa hsp did not show any cross-reactivity with the different anti-hsp 70 antibodies used. Two-dimensional electrophoretic analysis of *in vitro* translated poly(A)$^+$ RNAs extracted from control and heat-shocked cells showed that all the isoforms of the 77 kDa hsp are newly synthesized in heat-shocked cells. These mRNAs are being used to construct cDNA libraries for control and heat-shocked cells. Further studies on the heat shock response of *Choristoneura fumiferana* should be a valuable asset to our understanding of the effects of temperature on this pest insect and may help in its genetic control.

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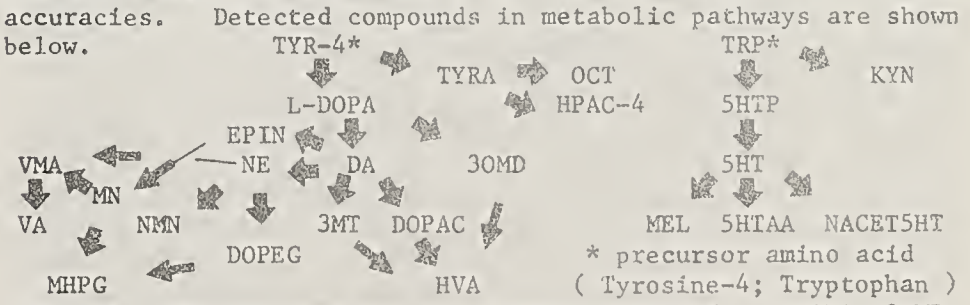
ACID AND ALKALINE PHOSPHATASES IN THE LARVAL GANGLIA OF BLACKFLY, WILHELMIA SAVOIENSIS EDW. QUALITATIVE AND QUANTITATIVE HISTOCHEMICAL ANALYSIS. V.Y.Dvornik (Department of Zoology, Donetsk State University, ul Universitetskaya, 24, Donetsk 340055, Ukraine)

Using histochemical methods it has been determined that acid glycerophosphatase is localized in neuropile and bodies of neurones but acid naphthylphosphatase (ANP) - in glial cells and their branches. Very weak diffusal positive reaction on alkaline naphthylphosphatase has been established only in cerebral ganglia of prepupa. Using cytophotometrical methods it has been shown ANP has higher activity in abdominal ganglia compared with cerebral and thoracic ones. An analysis of the obtained data and ones on other groups of insects testifies that phylogenetically more primitive insects have both alkaline (ALP) and acid (ACP) phosphatase in the ganglia localized in neurillema, perineurium and bodies of neurones. Phylogenetically more developed insects (Lepidoptera, Diptera) are characterized by a tendency to a localization of ACP in glial cells and to its predominance over ALP. From the evolutional point of view this fact can be explained that neurons become more specializing as their system organization becomes complicated, lose their metabolic functions which are passed on to glial cells.

DYNAMICS OF MONOAMINE METABOLISM IN THE CENTRAL NERVOUS SYSTEM OF SOME INSECTS. Naokuni Takeda, Hideo Takaoka (Department of Biotechnology, COSMO Research Institute, Satte, Saitama, 340-01, Japan), Toshiaki Shimizu (NISES, Tsukuba, 305, Japan) and Shigemi Yagi (TARC, Tsukuba, 305, Japan)

Our recent researches on the detection of biogenic monoamines examined mainly in the central nervous system of insects in wide ranges including dragonflies and cicadas were reviewed.

For detection, three dimensional HPLC system with coulometric electrochemical detection(ESA Inc. USA) was used. By the present HPLC, 30 compounds of biogenic amines and their metabolites were tried to detect simultaneously with the peak purity by ratio accuracies. Detected compounds in metabolic pathways are shown below.



* DA, NE, TYRA, OCT and 5HT were mainly detected. L-DOPA, 3OMD and KYN were also detected in many species. Epinephrine was not detected in all species examined.

* Main abbreviation: DA, dopamine; 3OMD, 3-O-methyldopa; NE, norepinephrine; TYRA, tyramine; KYN, kynurenine; 5HT, serotonin; OCT, octopamine; EPIN, epinine; VA, vanillic acid:

PYRUVATE CARBOXYLASE OF THE MOSQUITO, *A. aegypti* AND SOME OTHER INSECTS. Zhijian Tu & Henry Hagedorn, Entomology Dept. & Center for Insect Science, Univ. of Arizona, Tucson,AZ 85721, USA.

A major biotin-containing protein (128k) was found in 10 different species of insects by doing a western blot and staining with streptavidin-linked peroxidase. The major biotin-containing protein was purified, or partially purified, from the thoraces of honeybee (*Apis mellifera*), mosquito (*Aedes aegypti*) and the fat body of tobacco hornworm (*Manduca sexta*). The purified biotin-containing proteins were proven to be pyruvate carboxylase, an enzyme that catalyzes the specific transfer of a carboxyl group to pyruvate, yielding oxaloacetate. In the mosquito, the amount of pyruvate carboxylase in the thorax increased during development. There were two major biotin-containing protein bands (128k and 133k) in the SDS-PAGE of the partially purified mosquito pyruvate carboxylase. We do not yet know if both represent pyruvate carboxylase. The amino acid composition and the N-terminal sequences of these two bands were quite similar. Our attempt to generate a DNA probe for the pyruvate carboxylase gene from both adult mosquito whole body cDNA library and *Manduca* fat body cDNA library using PCR technique is reported. The comparison between pyruvate carboxylase of mosquito and those we purified from honey bee and tobacco hornworm, and the comparison between insect pyruvate carboxylase and those of other organisms are also reported. The possible physiological role of the pyruvate carboxylase in the thoracic muscles of insects is discussed.

EFFECTS OF INSECT GROWTH REGULATORS ON THE ACTIVITY OF CHITIN SYNTHASE AND 20-HYDROXYMONOOXYGENASE IN AEDES ALBOPICTUS. Chau-mei Ho, Chun-Feng Shih and Yau-Huei Wei(Department of Parasitology and Department of Biochemistry, National Yang-Ming Medical College, Taipei, Taiwan, China)

Insect growth regulators(IGC)are potent inhibitors for metamorphosis. The mechanism has not yet been understood. We investigated the effects of five IGRs, Chlorofluazuron, diflubenzuron, EL494, flufenoxuron and teflubenzuron, on the activity of chitin synthase and 20-hydroxymonooxygenase in Aedes albopictus. The activity of both enzymes was determined by radioassay in vitro. The pellet of larval homogenate by high speed centrifugation was used as the source of chitin synthase. Abdominal homogenate of female adults was used for the assay of 20-hydroxymonooxygenase. At the concentration of 100 ug/ml chlorfluazuron and teflubenzuon were found to have 24% inhibition for chitin synthase. But at the concentration of 10ug/ml, chlorfluazuron and flufenoxuron exhibited 80% inhibition for the activity of ecdysone 20-hydroxymonooxygenase. We suggest that the treatment of chlorfluazuron and flufenoxuron may change ecdysone metabolism which results in abnormal imaginable development.

DISTRIBUTION AND FUNCTION OF SEROTONIN ON THE GUT OF THE COLORADO POTATO BEETLE, *LEPTINOTARSA DECEMLINEATA*. Theo van Haeften (Department of Entomology, Wageningen Agricultural University, P.O.Box 8031, 6700 EH Wageningen, The Netherlands).

In *Leptinotarsa decemlineata*, the neuroactive compound serotonin has been shown to innervate the gut in a dual way. The foregut is innervated by the stomatogastric nervous system. From the hypocerebral ganglion three large serotonin-immunoreactive nerves arise which run along the oesophagus and cover the foregut with a network of serotonin-immunoreactive fibers. Especially, the sphincter between the crop and the midgut is strongly innervated. In a bioassy on isolated foreguts was shown that serotonin modulates the contraction of the foregut.

The hindgut is innervated by the ventral nervous system. Two large serotonergic neurons in the last abdominal ganglion send their axons into the rectal nerves. This nerve divides and one branch innervates the longitudinal muscles of the hindgut, whereas the other branch supplies the cryptonephridial system. In a bioassy on isolated hindguts was demonstrated that low concentrations of serotonin modulate the spontaneous contractions of the hindgut. Proctolin-induced contractions of the hindgut were also modulated by low doses of serotonin.

No immunoreactivity was present in the midgut.

On the Latency and Nature of Phenoloxidase present in the plasma of poicilocerus pictus. A.VINAYAKAM (Post Graduate & Research Department of Zoology, Sir Theagaraya College, Madras 600 021, India),K.NELLAIAPPAN (Department of Zoology, University of Madras, Madras 600 025 India).

The Phenoloxidaseof plasma exist in the form of proenzyme in Policilocerus pictus. The proenzyme could be activated by detergents, proteases and organic solvents. Among the detergents used Sodium dodecyl sulphate activation in maximum than others. Among the proteases tested chymotrypsin activated the proenzyme much higher than other proteases. Among the organic solvents used methanol seems to be the best activator of prophenoloxidase. The enzyme readily oxidized o-diphenols such as dopa, dopamine, N-acetyl-dopamine and 4-methylcatechol. It neither oxidized monophenols nor p-diphenol, hydroquinone. Among the inhibitors tested phenylthiourea, Diethyldithiocarbamate, mercurie chloride and potassium cyanide inhibited drastically. Properties and role of the enzyme were discussed.

ENDOCRINE REGULATION AND CHEMICAL DISRUPTION OF EMBRYONIC DIAPAUSE IN THE GYPSY MOTH, LYMANTRIA DISPAR L. R.A. Bell (INHL-BARC-E) and A.B. DeMilo (ICEL-BARC-W), Plant Sciences Institute, ARS,USDA Beltsville, MD 20705

The gypsy moth is univoltine in nature and enters an obligatory diapause as a differentiated pharate larva following 2-3 weeks of embryonic development. Entry into diapause occurred after the appearance of peak titers of prothoracicotropic and ecdysteroid hormones that produced a surge of metabolic activity associated with synthesis and differentiation of the final embryonic larval cuticle. Diapause was characterized by a subsequent low level of metabolic activity (oxygen consumption) and the disappearance of ecdysteroid hormones. Treatment of 13-15 day old (pre-diapause) eggs by immersion in acetone solutions of KK-42 (an imidazole terpenoid with anti-juvenile hormone activity), prevented diapause and 50-70 % of the eggs hatched in 4-10 days. KK-42 was ineffective in re-activation of development after entry into diapause but caused accelerated diapause termination and synchronous hatching in eggs chilled for 2 months. It is concluded that late embryonic diapause in the gypsy moth involves some degree of regulation by juvenile hormone but the mechanism is not yet understood.

PUPAL DIAPAUSE OF THE ORIENTAL TOBACCO BUDWORM,HELICOVERPA ASSULTA. K.S.Boo,H.C.Shinn,K.H.Cho(Dept. Agric.Biol., Coll. Agric., Seoul Natl.Univ., Suwon 441-744, Rep. Korea), M.W.Han, M.H.Lee(Dept. Entomol., Agric. Sci. Inst.,RDA, Suwon 441-707, Rep. Korea)

H.assulta is the most serious insect pest to the hot pepper in Korea, with its larvae feeding inside the fruits. The species overwinters as diapausing pupae in soil. Diapause induction was dependent on photoperiod and temperature experienced by late(4th & 5th) instar larvae. The critical photoperiod wa 12-12.5 hours at 25C and 14-14.5 hours at 20C. Field-collected larvae started to go into pupal diapause in late August and the diapause rate increased as the season progresses, to reach one hundred percent in those collected in late September/early October. Adults, eggs, pupae, or early instar lavae did not respond to this diapause-inducing condition. Cold temperature treatment was not necessary in diapause termination but shortened the diapause period.

Total contents of carbohydrate and soluble protein were higher in diapausing pupae than in non-diapausing pupae. Diapausing pupae increased their hemolymph osmolarity only when exposed to low temperature. This high osmolarity was mainly due to higher content of glucose,sorbitol and trehalose. But proteins did not show any difference, in terms of electrophoretic bands, between diapausing and non-diapausing pupae.

STUDIES ON THE SENSITIVE STAGE OF DIAPAUSE INDUCTION IN THE ASIAN CORN BORER (ACB), OSTRINIA FURNACALIS (GUENEE) .Rui-lin Liu. Yun-liang Fan. Xin-sheng Wang. Zhang-wu Zhao. Jing -bin Wang (Dept.of Biology. Shanxi Univ. Taiyuan. 030006. China).

In order to determine whether there is a special larval stage during which the diapause induction is most effective. 16 test groups of the ACB were reared at 27℃ , and to 12h.or 16h . photophases. then transferred to opposite photoperiods at different instar. Diapause incidence (DI) was determined at 35 days after larval eclosion.(1) 1-4 single instar exposure to short photophase(SP) only had 4.9-14.8% of DI. but in 5 instar there was a 21. 9% of DI. This indicates that the diapause is somewhat reversible in early instars. (2) Any 2 adjacent instars exposure to SP resulted in a 20. 5-41. 9% of DI .It shows that the diapause were cumulated . (3). the combination of 3 adjacent instars exposure to SP produce a moderate DI, however,in the 1-3instars,the DI(55.4%) is greater than both 2-4 instars (50. 1) and 3-5 instars (34.8). It shows that DI declines with larval age at time of exposure to diapausing conditions.(4) If the sensitive stage is defined as the period at which half of the test borers undergo diapause under a SP, the sensitive stage will be 2-4 instars. during which the DI reach 50. 1% .However,if estimated graphically,the critical larval instar will be 2.67.

STUDIES ON THE SEX PHEROMONE OF CHINESE JUJUBE LEAFROLLER MOTH *ANCYLIS SATIVA* LIU. Lianchang Li , Lizheng Li, Yi Yan, Yongliang Fan, Guanglu Shi, Meijun Zhao, Jie Li (Institute of Entomology, Shanxi Agricultural University, Shanxi 030801, China)

Jujube leafroller moth (*Ancylis sativa* Liu) is one of the most important pests on jujube trees in China. In the past, it was controlled by pestisides. Not only result in the resistance, but also kill the natural enemies and disrupt the ecology balance. The damage caused by the pest never reduced but increased. At the same time, the fruits and environment were polluted. Therefore, looking for the way without environmental pollution is a pressing task. In 1976, we found that live virgen female moth attracted male moth strongly in the field. In July 15, 1977, 5 virgen females attracted 1122 males a day. Therefore, On the basis of knowing the life cycle and bionomics especially the sexual behaviors of adults, associated with Shanghai Organic Chemistry Institute, sex pheromone of *Ancylis sativa* has been identified, synthesized and tested with monitoring, mass — trapping and mating disruption methods, a new integrated approach for the pest control mainly by pheromone has been found.

DIAPAUSE ASSOCIATED PROTEIN IN PINK BOLLWORM. T. A. Miller (Entomology Department, University of California, Riverside, CA 92521)

Short day length induces biosynthesis of a specific protein, pectinophorin, in fourth instar larvae of pink bollworm, *Pectinophora gossypiella* (Saunders). Pectinophorin, a 103 KD protein, makes up some 40% of the hemolymph protein content as a lipo-glycoprotein until diapause is broken after which pectinophorin can no longer be detected. *In vitro* translation of total RNA from fat body of diapause larvae showed the presence of poly $(A)^+$ RNA sequence of pectinophorin. Northern hybridization analysis revealed that active feeding larvae maintain a relatively low level of pectinophorin mRNA in their fat body cells prior to induction of diapause. ELISA assays based on purified pectinophorin were invaluable for use in determining larvae diapause in field collected animals.

ELECTROPHYSIOLOGICAL AND BEHAVIORAL RESPONSES TO SEX PHEROMONE COMPONENTS IN MALE *SPODOPTERA EXIGUA* (LEPIDOPTERA: NOCTUIDAE) .

Mochizuki F., S. Wakamura (Nat. Inst. Seric. Entomol. Sci.), M.Takai (Kochi Pref. Inst. Agric. For. Sci.) and T. Shibuya (Univ. Tsukuba)

Four compounds, (Z,E)-9,12-tetradecadienyl and (Z)-9-tetradecenyl acetates (I, II) and their corresponding alcohols (III, IV), were found in female glands of *S. exigua* in Japan. Four types of olfactory receptor cells in male moths were recognized in single sensillum responses to these compounds: Two types (A, B) observed in male specific trichodea (ca. 100 μm long) specifically tuned by the attractive components (I) and (IV), respectively. Type B were also excited by the dienyl alcohol (III), which released an orientation behavior in field tests when combined with component (I). The other two cell types (C, D), found in short trichodea (ca. 40 μm) mainly in the distal half of the antennae, were fired by higher concentrations of component (I) and (IV), respectively. Removal of the distal parts of the male antennae did not affect its upwind flight to a blend of (I) and (IV), but did reduce the number of trap captures in flight tunnel test. In the light of these results, type A and B cells were suggested as long range orientation receptor cell, C and D as short range receptor cells. The dienyl alcohol (III) was supposed to have the same physiological effect as the monoenyl alcohol (IV).

BIOSYNTHESIS OF THE PHEROMONE COMPONENT IPSDIENOL IN THE BARK BEETLE, *IPS DUPLICATUS* (SCOLYTIDAE: COLEOPTERA)

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The biosynthesis of ipsdienol was studied by using the enzyme inhibitor compactin (mevilonin). The inhibitor blocks the action of hydroxymethylglutaryl-coenzyme A reductase, an early enzyme in the terpenebiosynthesis. The compactin were injected in the beetles abdomen using a thin tapered glass needle. Controls were, using the same technique, injected with physiologic saltsolution (0.9 % NaCl). To rule out the possibility that the inhibitor causes an unspecific metabolic depression of the beetles, *Ips typographus* was subjected to the same treatment and monitored for the hydroxylation of (-)-α-pinene, giving *cis*-verbenol. The production of *cis*-verbenol is not affected by compactin. By showing that the production of ipsdienol is reduced by approximately 70 % as the beetles is injected with compactin, we conclude that ipsdienol can be synthesized *de novo* and not only as a hydroxylation of myrcene, present in the resin of the attacked trees.

IDENTIFICATION OF AROMATIC AMINO ACID RICH STORAGE PROTEIN IN AMERICAN COCKROACH. O.P.Agrawal, Rashmi Sardana, M.L. Pathak (School of Studies in Zoology, Jiwaji University, Gwalior 474011, India)

The haemolymph and fat body samples during late postembryonic development of American cockroach, Periplaneta americana L. were subjected to native and SDS-PAGE and specific staining of gels was performed for protein, lipid, carbohydrate and aromatic amino acid containing molecules. Two hexameric lipo-glyco-proteins rich in aromatic amino acid content and having subunit molecular weight of 90000 and 83000 have been identified, of which the high MW protein seems to be homologous to the storage arylphorins of holometabolous insects. However, the typical temporal pattern of storage proteins i.e., fat body concentration increases as the haemolymph level declines, was not observed. This might be due to the fact that cockroach, like holometabolous insects does not have a prolonged non-feeding period comparable to the pupa and hence there is no need for storage of large amounts of nutrients and the protein might directly be taken up by the tissues concerned.

SCE INDUCTION IN A MOSQUITO CELL LINE CONTAINING SOME NO BACKGROUND-SCE CELLS. K.Y. Jan (Institute of Zoology, Academia Sinica, Taipei 11529, Taiwan, China), Roger F.N. Hou (Dept. Entomol., National Chung-Hsing University, Taiwan, China), L.Y. Wei (National Science Council, Taiwan, China)

Although SCE induction has been used as an indicator of genetic toxicity, its relationship to DNA damage and repair are yet unclear. Cultured lepidopteran and mosquito cells have been reported to have a remarkable resistance to the cell killing of many mutagens in comparison to mammalian cells. We have then compared the SCE induction by various types of DNA damaging agents in mosquito cells (Aedes albopictus, cell line C6/36) and Chinese hamster ovary cells. In both cell line, all mutagens tested induced more SCE in low than high concentration of bromodeoxyuridine. Mitomycin C, methyl methanesulfonate, amsacrine and luminol induced more SCE in rodent cells whereas, 2-aminopurine induced more SCE in mosquito cells. In the mutagen-treated mosquito cells, elevation of SCE frequency were coupled with decreasing frequency of 0-SCE cells. However, at high bromodeoxyuridine concentration, with increasing doses of 2-aminopurine, the frequency of 0-SCE cells remained unchanged.

MAJOR HAEMOLYMPH PROTEIN FROM LARVAE OF THE CABBAGE MOTH (*MAMESTRA BRASSICAE* L.). Mirko Slovák, Vladimír Repka, Milan Kozánek (Institute of Experimental Phytopathology and Entomology SAS, 900 28 Ivanka pri Dunaji, Czechoslovakia), Jiří Vohradský (Institute of Microbiology CSAS, Vídeňská 1083, 142 20 Praha 4-Krč, Czechoslovakia).

The major protein was isolated and partially characterized from larval serum of the cabbage moth (*Mamestra brassicae L., Lep. Noctuidae*). The storage protein was purified into electrophoretic homogeneity by means of ionex chromatography and electroelution. It is a glyco-lipoprotein. SDS-polyacrylamide gel electrophoresis suggested that this protein is composed of non-identical two dominant subunits of M_r 81.9 and 74.6 kD and four minor subunits of M_r 64.1, 58.3, 40.8 and 38.2 kD. An electrofocusing separation showed the presence of these subunits at pH 5.4-6.3. *M. brassicae* storage protein is immunologically related to *Lymantria dispar (Lep., Lymantriidae)* Arylphorin but it did not cross-react with antibodies prepared against Lipophorin from *L.dispar*.

LOCALIZATION OF CARBOHYDRASES IN SOME INDIAN ORTHOPTERANS. C.N. Srivastava (Department of Zoology, Faculty of Science, Dayalbagh Educational Institute (Deemed Univ.) Agra - 282 005, India)

The activity of various carbohydraes were investigated in *Gryllotapa gryllotalpa, Schizodactylus monstrosus* and *Gryllus domesticus*. The carbohydrases in salivary glands are represented by amylase and maltase in *G. gryllotalpa* and *G. domesticus* and only by amlyase in *S. monstrosus*. In the stomodaeal region carbohydrases are represented by amylase, invertase, maltase and traces of raffinase in *G. gryllotalpa*, by amylase, chitinase, maltase and traces of invertase in *S. monstrosus* and by amylase, maltase and traces of rafinase and invertase in *G. domesticus*. The activities of amylase, cellulase invertase and maltase were localized in the mesenteron of *G. gryllotalpa*. In *S. monstrosus*, the activities of amylase, chitinase, invertase and maltase were observed in its mesenteron. Chitinase and cellulase both are present along with amylase, invertase and maltase in the mesenteron of *G. domesticus*. In their hindgut negative trend in carbohydrases activity was detected. the activity of maltase is greater than that of amylase and invertase in all the three insects. Thus the carbonhydrases exhibit higher activities in midgut in comparision to foregut and hindgut.

#1

COPULATION AND INSEMINATION OF THE HETEROCERA Zu Lin Zhou

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By applying the living body experimental method of extrabody's bursae copulatrix to copulate, we have directly observed the moth copulating and insemination process. The whole process of copulation can be divided as five periods: prophase (preparative for copulation), primary phase (collum spermatophore formation), metaphase (corpus spermatophore formation), anaphase (spermatophore release), telophase (copulation perfective).

The process of expelling matters by the male moth during metaphase is divided into six stages: sheath matter, external wall matter, interisolator, internal membrane matter, semen and accessory gland secretion. There is a very strict rule about the process and time needed in those periods and stages.

The spermatophore formation and release depend on the male moth. But the spermatophore's location in the bursae copulatrix depend on the female moth.

Some species moth aedeagus have air expelling function during copulating periods.

#2

22-DEOXY-20-HYDROXYECDYSONE: A NEW ECDYSTEROID IN MATURE OVARIES OF THE SILKWORM, BOMBYX MORI

Mari Kamba, Haruyuki Sonobe (Department of Biology, Konan University, Higashinada-ku, Kobe 658, Japan), Yoshinori Fujimoto (Department of Chemistry, Tokyo Institute of Technology, Meguro-ku, Tokyo 152, Japan)

Ovarian ecdysteroids of the silkworm, Bombyx mori, were analyzed by a combination of reverse-phase HPLC and RIA. An unidentified ecdysteroid was eluted between 2-deoxy-20-hydroxy-ecdysone and 2-deoxyecdysone, in addition to various ecdysteroids that have already been identified in the silkworm ovaries.

In order to analyze the chemical structure of the unidentified ecdysteroid, we purified the ecdysteroid and finally obtained about 200 µg of purified sample from about 3 kg of ovaries. This compound was identified as 22-deoxy-20-hydroxyecdysone (22D20HOE) by mass spectrometry and NMR. This is the first demonstration of the accumulation of 22D20HOE in insect ovaries. We will discuss a possible pathway for the biosynthesis of ovarian ecdysteroids in the silkworm.

#3

EDCYSTEROIDS DURING EMBRYOGENESIS IN *HYALOPHORA CECROPIA*. Elaine C. Rubenstein (Department of Biology, Skidmore College, Saratoga Springs, NY 12866, U.S.A.) and Thomas J. Kelly (USDA-ARS, Insect Neurobiology & Hormone Lab, Beltsville, MD 20705, U.S.A.)

During oogenesis, ecdysteroids are sequestered in developing oocytes of the silkmoth *Hyalophora cecropia*. In mature eggs, highly polar ecdysteroids are the predominant form. We have analyzed the ecdysteroid content of eggs after fertilization by both radioimmunoassay (RIA) and reverse phase high performance liquid chromatography (HPLC). RIA titers show two ecdysteroid peaks, one at 4 days, and another at 9 days of a 14 day embryonic period. The HPLC analysis reveals a change in the ecdysteroid profile, from a high concentration of highly polar ecdysteroids initially, to a predominance of 20-OH-ecdysone, coincident with the second RIA ecdysteroid peak.

#4

CALMODULIN IN DEVELOPING EMBRYOS OF THE SILKWORM BOMBYX MORI. Hajime Fugo (Department of Environmental Sciences and Resources, Faculty of Agriculture, Tokyo University of Agriculture and Technology, Fuchu-shi, Tokyo 183, Japan), Guo-Zheng Zhang (The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang City, China).

Calmodulin from developing embryos of the silkworm, Bombyx mori, was purified by trichloroacetic acid precipitation, heat treatment, ion-exchange chromatography and hydrophobic interaction chromatography. Bombyx calmodulin showed close similarity to other calmodulins investigated so far in the amino acid composition and in demonstrating an altered migration on SDS-PAGE upon Ca binding. Calmodulin dependent phosphodiesterase (PDE) was extracted and partially purified from the rabbit brains and it was examined whether the Bombyx calmodulin can stimulate the rabbit PDE or not. It was observed that Bombyx calmodulin can stimulate the rabbit PDE activity at dose dependent manner. Furthermore, the calmodulin stimulation of PDE was inhibited by the addition of W-7, one of the calmodulin inhibitor, in dose dependent fashion. Amino acid sequence of Bombyx embryo calmodulin will be demonstrated and the fluctuation of the calmodulin during the embryogenesis of the silkworm will be also discussed.

#5

ACID CYSTEINE PROTEINASE FROM THE EGGS OF SILKMOTH, *BOMBYX MORI*: EFFECT OF VITELLIN PHOSPHORYLATION ON THE SUSCEPTIVITY TO THE ENZYME. Y.Yamamoto, S.Y.Takahashi, (Dep. of Biol., Fac. of Liberal Arts, Yamaguchi Univ., Yamaguchi, Japan), T.Kageyama, (Dept. of Biochem. Primate Res. Inst., Kyoto Univ., Kyoto, Japan), X.Zhao. (Dept. of Biol., Shandong Univ., Shandong,).

In the developing silkmoth eggs, vitellin (Vn) is degradated in a limited manner. Cysteine proteinase (CP) from the silkmoth eggs was able to degradate the Vn *in vitro* with a pattern similar to that found *in vivo*, suggesting that the involvement of the CP in the degradation of Vn. When Vn was phosphorylated by cGMP-dependent protein kinase (G-kinase), which is abundant in the early developmental periods of the eggs, prior to exposure to CP, there was a marked increase in the susceptibility of Vn to degradation by CP. The phosphorylation lowered the Km value of CP for the substrate, Vn. Phosphorylation of Vn in intact developing eggs was also demonstrated by microinjection of ^{32}P phosphoric acid but no phosphorylation was observed in diapause eggs. From the results, it appears that the phosphorylation of Vn serves as the trigger for the proteolytic digestion of Vn during the development of eggs, and that the one of the functions of the kinase in the eggs might be to provide the signal for the degradation of Vn by the cysteine proteinase.

#6

TISSUE DISTRIBUTION, SYNTHESIS LOCATION AND QUANTIFICATION OF ACID CYSTEINE PROTEINASE IN THE EGGS OF SILKWORM BOMBYX MORI .Xiaofan Zhao (Department of Biology, Shandong University, Jinan, Shandong, 250100 China), S.Y.Takahashi (Department of Biology, Faculty of Liberal Arts, Yamaguchi University, Japan)

The tissue distribution, synthesis location and quantification of the acid cysteine proteinase in the silkworm, Bombyx mori were studied by means of activity assay and immunological experiments. The results showed there were acid cysteine proteinases in oocytes and hemolymph. However, the activity and quantity of the enzyme in oocytes was much higher than hemolymph. The activity of the enzyme could be inhibited by N-[N-(1,3-trans-carboxyoxiran-2-carbonyl)-L-leucyl]-agmatine (E-64), a specific inhibitor of cysteine proteinase. The results of radiolabelling experiment suggested the acid cysteine proteinase could be synthesized in both of oocytes and hemolymph, and they are immunologically identical, but the relationship between them needs to be clarified further. The acid cysteine proteinase appeared in the oocytes at the 5th day after the pupation, but it appeared in the hemolymph throughout the pupal period.

#7

ACID CYSTEINE PROTEINASE FROM THE EGGS OF THE SILKMOTH,BOMBYX MORI. REGULATORY MECHANISM OF THE ENZYME ACTIVATION AND YOLK PROTEIN DEGRADATION. S.Y.Takahashi,Y.Yamamoto (Dept.Biol., Fac. Liberal Arts,Yamaguchi Univ.,Yamaguchi,Japan), X.Zhao (Dept. Biol. Shandong Univ.,Shandong,), T.Kageyama (Dept.Biochem.,Primate Res.,Kyoto Univ.,Japan.

Cysteine proteinase found in the eggs of the silkmoth,Bombyx mori, can be activated during incubation in the acidic medium (pH 3.5). Activation requires the presence of substrates in the incubation medium and is inhibited by E-64, specific inhibitor for cysteine proteinases. Concomitant with the activation,the proteinase (47 kDa) is converted to a smaller protein (43 kDa), indicating that partial proteolysis of the enzyme is likely to be involved in the activation process.

The same pattern changes occur in intact eggs at the beginning of embryogenesis and the activated form of the enzyme can be detected throughout the embryonic life.

These facts strongly suggest that cysteine proteinase is stored in the eggs as a proenzyme which is latent and is activated by partial proteolysis during embryogenesis.

The regulatory mechanisms of the cysteine proteinase and involvement of the proteinase in the yolk protein degradation will be discussed in relation to the embryogenesis of the silkmoth, Bombyx mori.

#8

THE ROLE OF LIPOPHORIN DURING MATURATION OF OOCYTE IN HYPHANTRIA CUNEA D. Hwa-Kyung Yun and Hak-Ryul Kim(Department of Biology, Korea University, Seoul 136-701, Korea)

Lipophorin of *Hyphantria cunea* D. has been purified by KBr density gradient ultracentrifugation . The composition of lipids and fatty acids in lipophorin has been determined using thin-layer chromatography(TLC) and gas chromatography(GC). Lipophorin is composed of two subunits, apo-Lp I (M.W.=230,000) and apo-Lp II (M.W.=80,000) and the lipids in lipophorin comprised triacylglycerol(TG), diacylglycerol(DG), monoacylglycerol(MG), free cholesterol and phospholipids(phosphatylethanolamine, phosphatidylcholine and sphingomyelin). The role of lipophorin during maturation of oocyte has been studied.

#9

FATE AND DIFFERENTIATION OF VITELLOGENIN-2 IN MATURING OOCYTE OF PERIPLANETA AMERICANA. Sang-Dae Lee and Hak-Ryul Kim (Department of Biology, Korea University, Seoul 136-701, Korea)

Vitellogenin(Vg) and vitellin(Vn) of *Periplaneta americana* were purified by ultracentrifugation, ion exchange chromatography (DEAE cellulose and DEAE sepharose CL 6B) and Gel filtration (sepharose 4B, sephadex G-200). The purified Vg and Vn were confirmed by electrophoresis and electron microscopy. The compositions of lipids and carbohydrates of Vg and Vn were analysed by TLC, Iatroscanner and gas chromatography. The uptake and deposit of vitellogenin were investigated by autoradiography and immunoelectron microscopy. Fate and differentiation of Vg during oocyte maturation have been discussed.

#10

STRUCTURE AND EXPRESSION OF A GENE CODING FOR EGG-SPECIFIC PROTEIN IN THE SILKWORM, *BOMBYX MORI*. Y. Sato (Radioisotope Research Center, Nagoya Univ.) and O.Yamashita (School of Agriculture, Nagoya Univ., Chikusa, Nagoya 464-01, Japan).

Egg-specific protein (ESP) is a yolk protein which is synthesized in developing ovarian follicles of the silkworm, *Bombyx mori*. We have isolated a gene coding for ESP from a genomic DNA library using cDNA as a probe and sequence about 2.9 kb including 5'- and 3'- flanking regions. Three closely located sites were identified as transcription initiation sites by primer extension analysis. In the 5'-upstream region, there are several short sequences which are similar to the regulatory elements of other genes: short sequences homologous to the ecdysteroid response elements of the heat shock protein genes and the glue protein genes, cis-acting elements of chorion genes, and a protein factor binding site of the fibroin gene. Southern hybridization analysis revealed the presence of a single copy of the ESP gene per a haploid genome. Nucleotide sequence of the ESP gene was highly similar to yeast lipase gene. There was 35% similarity in amino acid sequence of ESP to lipases of human and rat. Thus, ESP is assumed to be evoluted from a common ancestor of lipase family members. Northern hybridization analysis of RNA prepared from various tissues at different developmental stages showed that the ESP gene is expressed only in vitellogenic follicles. In the isolated pupal abdomens in which ovarian growth was ceased at early vitellogenesis, ESP mRNA was quitely low level. The injection of 20-hydroxyecdysone to these abdomens activated the transcription of the ESP gene and resumed growth of ovaries.

#11

WHICH IS A MAJOR HORMONE FOR VITELLOGENIN GENE EXPRESSION IN HOUSEFLY: THE COMPARATIVE STUDIES ON THE ROLES OF ECDYSTEROID AND JUVENILE HORMONE. Noriaki Agui (Department of Medical Entomology, The National Institute of Health, Tokyo,JAPAN), Toru Shimada (Department of Agricultural Biology, University of Tokyo, JAPAN), Susumu Izumi and Shiro Tomino (Department of Biology, Tokyo Metropolitan University, Tokyo, JAPAN)

In housefly, Musca domestica, the vitellogenin mRNA accumulates in a sex-, stage- and tissue-specific fashion during gonotropic cycle. Ecdysteroid acts on vitellogenin gene transcription more pronounced than juvenile hormone. Here, the roles of ecdysteroid and juvenile hormone for the expression of housefly vitellogenin were further investigated.

The ecdysteroid levels increased in female hemolymh and ovary by the treatment of juvenile hormone analog (methoprene, JHA) to adult flies, but JHA showed no effect on male flies. The JHA induced higher ecdysteroid levels in ovaries in vitro. Furthermore, the ecdysteroid-receptor concentration of female flies was higher than that of male flies in the early adult stage. These results strongly indicate that the role of juvenile hormone on the vitellogenin gene expression of housefly are indirect action madiating the stimulation of ecdysteroid synthesis in the ovary. The significant differences of ecdysteroid-receptor concentration between female and male might be a major factor for the sex-specific expression of housefly vitellogenin gene

#12

HORMONAL CONTROL OF THE OOCYTE DEVELOPMENT IN *Lucilia illustris*. Jong-Jin Lee*, Kwang-Yeop Jahang**(Department of Agricultural Biology* & Biology,** Chonbuk National University, Chonju 560-756, Korea), Se-Won Oh(Kwangju Health Junior College, Kwangju 506-306, Korea)

The interaction of oocyte development and hormonal control during the first reproductive cycle in the blowfly, *L. illustris* were studied. The duration of the oocyte maturation was 4 days after liver-feeding. Fat body and haemolymph proteins increased rapidly between 48 and 60 hr while ovarian protein increased from 60 hr to oviposition. Allatectomy and treatments of methoprene and precocene for the adult females have done and the effects of those on the oocyte development will be given.

#13

TIMING OF PROTHORACICOTROPIC HORMONE(PTTH) RELEASE AND THE EFFECT OF NEUROTRANSMITTER ON ITS RELEASE, IN THE LARVAE OF SILKWORM, BOMBYX MORI. Y.Shirai, Y.Aizono, T.Iwasaki(The Graduate School of Science and Technology, Kobe Univ. Kobe, Hyogo 657, Japan), H.Mori, M.Sumida, F.Matsubara (Dept. of Applied Biology, Kyoto Institute of Technology, Matsugasaki, Kyoto 606, Japan).

In order to yield information on the endocrine cascade of the insect, in vivo and in vitro release of PTTH in the larvae of silkworm was studied. The titer of PTTH was measured indirectly by its ability to stimulate the ecdysone secretion from cultured prothoracic glands. A monoclonal antibody against ecdysone was used for its radioimmunoassay. Timing of PTTH release into hemolymph was detected 5 times in 5th-larval instar; those were on day 1~2, day 4, day 6(one day before wandering), at prepupal stage and on the day just before the maximum level of ecdysteroid titer in hemolymph. Since these PTTH releases evidently related with the activity of the brain-corpus cardiacum-corpus allatum to release PTTH in vitro, the effects of ions and neurotransmitters on the PTTH release from Br-CC-CA were examined. In media contg. 100 mM K^+, the release was stimulated in dependence on Ca^{2+}, indicating that depolarization of neurosecretory cells was associated with Ca^{2+}-participant neurohormone secretion. Among neurotransmitters involved in "the stimulus-secretion coupling", acetylcholine as well as glutamate stimulated the PTTH release significantly. The details on the role of the effective transmitters in the PTTH release will be presented.

#14

NEUROCONTROL FACTORS OF ECDYSONE BIOSYNTHESIS FROM BRAIN OF BLOWFLY, *CALLIPHORA VICINA*. Yuejin Hua, Del Bradbrook, Gerd Käuser and Jan Koolman (Physiol. Chem. Institut, University of Marburg, D-3550 Marburg, Germany)

Ecdysone synthesis appears to be under a complex neural control. In larvae of the blowfly, *Calliphora vicina*, a dual control of the producing gland by the brain was observed, mediated both by neurohormones and by innervation. To analyze the neurohormones involved in the control of ecdysone synthesis, ecdysiotropin was extracted from the brain of larvae of the blowfly, *Calliphora vicina*, partially purified and characterized by gel chromatography. *In vitro* assay of ring glands with the fractions obtained from gel chromatography revealed the existence of two forms of ecdysiotropin: a large form with molecular mass of 14-15 kDa and a small form with 4-5 kDa, confirming the observation made with other holometabolous insect species that two size-classes of ecdysiotropins (prothoracotropic hormones) exist in the last larval stage. Moreover, an inhibitory neurofactor with molecular mass of 13-14 kDa was observed. The inhibitory neurofactor *in vitro* was functionally similar to the moult inhibiting hormone (MIH) of crustacea. This raises the possibility that the control of ecdysone synthesis in insects and crustacea shares some basic principles.

#15

THE IMPORTANCE OF THE SIDE-CHAINS AND THE STEREOCHEMISTRY OF ALLATOSTATIN 4 (AST4) ON THE INHIBITION OF JH BIOSYNTHESIS. Xue-Chen Guan, T.K. Hayes* and S.S. Tobe (Department of Zoology, University of Toronto, Toronto, ON, M5S 1A1, Canada and *Department of Entomology, Texas A&M University, College Station, TX, 77843-2475, USA)

Analogues of AST4 (Asp-Arg-Leu-Tyr-Ser-Phe-Gly-Leu-amide) with substitution of single amino acid residues with Ala or D-amino acids had different effects on JH biosynthesis by the CA of *Diploptera punctata* that suggest important structure-activity relationships (SAR). Analogs were synthesized by tBoc solid phase peptide synthesis. Each analog was purified by HPLC and the amino acid composition and peptide quantity determined by amino acid analysis. The radiochemical in vitro assay for JH biosynthesis was used to test SAR.

Analogs with single Ala replacements helped define the relative importance of AST4 side-chains for carrying the information that results in inhibition of JH biosynthesis. Replacement of hydrophobic amino acid side-chains (Tyr^4, Phe^6, Leu^8) located towards the C-terminus of the peptide resulted in the lowest potency analogs. These side-chains appear to be most important for receptor interaction. The addition of bulk in the L-configuration of Gly^7 resulted in a large potency loss. The importance of the lack of side chain bulk or a D-configuration in the seventh position of AST4 may be important for the receptor-hormone fit.

Analogs with a single replacement with a D-amino acid were also tested. The results suggest that a conformation emphasizing C-terminal amino acids is important for receptor interaction. There was a consistent loss of analog potency as the replaced amino acid was moved toward the C-terminus (i.e. [$D\text{-}Leu^8$]-AST4 is the least potent analog). The only exception to this observation was that the replacement of Gly^7 with a D-Ala resulted in a potent analog. Since the D-configuration is preferred for position 7, exploration for the existence of a type II ß-turn centered between positions 6 and 7 is warranted. Additionally, crowding by receptor or AST4 residue(s) is expected to influence the orientation of the position 7 amino acid residue when the hormone is bound to the receptor.

#16

SYNTHESIS OF A *MANDUCA SEXTA* ECLOSION HORMONE (EH) ANALOG AS A MODEL PEPTIDE FOR PROTEIN FOLDING STUDIES. Yajun Wang, Lale Yurttas, Bruce E. Dale (Department of Chemical Engineering); Mark S. Wright and Timothy K. Hayes (Department of Entomology; Texas A&M University, College Station, TX 77843, USA)

Insect cell cultures are gaining prominence for production of agriculturally and medically important proteins. Even though gene-related proteins are translated appropriately in insect cell expression systems, some proteins are not processed or folded correctly. These expression errors often result in biologically inactive proteins. Analogs of *M. sexta* EH are being developed in our laboratories to examine the potential for selective point mutations to control protein folding. Analogs of *M. sexta* EH are promising models for protein folding studies because of several structural features: The native peptide is 62 amino acid long which qualifies it as a small protein that can be synthesized chemically. Three disulfide bonds exist within EH. The bond rearrangements permit trapping of the folding intermediates to identify folding pathways. The developed [Asn^{20}]-EH analogs allow for enzyme digestion for easy identification of disulfide bond pairings. The labile amino acids Met and Trp might be replaced with stable amino acid analogs. A simple bioassay is available to detect the native conformation of EH and its analogs. Stability studies are performed to understand point mutations that can direct protein folding toward biologically important conformations.

EH, [Asn^{20}]-EH and a stabilized analog have been synthesized by Fmoc solid-phase peptide synthesis and folded into active proteins. Various characterizations (ie. via HPLC, laser MS, FTIR and bioassay) will be described.

#17

STRESS INDUCED RELEASE OF HYPERGLYCAEMIC HORMONE AND HYPERGLYCAEMIC HORMONE PEPTIDASE IN THE AMERICAN COCKROACH. Shigui Liu and J.E. Steele (Department of Zoology, University of Western Ontario, London, Ontario, Canada N6A 5B7.)

The induction of chemical stress in cockroaches by treatment with lindane (10 µg in acetone) applied topically to the abdominal tergites causes a significant reduction in the level of trehalose in the haemolymph. This decrease occurs earlier and in a more precipitous manner in cockroaches that have been ligated at the neck. These results suggest that during the early phase of lindane intoxication trehalose levels are maintained by the release of hyperglycaemic hormone from the corpora cardiaca. This conclusion is supported by measurements of the amount of hyperglycaemic hormone that can be extracted from the haemolymph of normal, lindane treated and neck-ligated lindane treated cockroaches. Concomitant with the release of hyperglycaemic hormone to the haemolymph in lindane treated insects a factor appears in the haemolymph that causes the destruction of the hormone. The release of this factor is controlled by a centre in the head since it does not appear in the haemolymph of neck-ligated cockroaches. The concentration of the factor in the haemolymph is time dependent and attains its highest concentration approximately 12 hours after treatment with the lindane. The evidence obtained suggests that the factor responsible for the destruction of the hyperglycaemic hormone is a protease. The potential role of this enzyme as a regulator of hyperglycaemic hormone in the haemolymph is being investigated.

#18

ADENOTROPIC NEUROHORMONES IN *DROSOPHILA*. D.Zitnan, F.Sehnal, P.J.Bryant (Developmental Biology Center, University of California, Irvine, CA 927171, U.S.A.)

Antibodies to *Bombyx mori* PTTH and bombyxin and *Manduca sexta* allatotropin react in *Drosophila* with specific sets of neurons, some of which appear homologous to the recognized sources of the examined neurohormones in Lepidoptera. Double staining revealed that antigens detected with employed antibodies in *Drosophila* are never co-localized. PTTH immunoreactivity occurs in feeding larvae in 2 pairs of lateral neurons in the brain and 15 pairs of lateral neurons in the ventral ganglion. It is high in the wandering larvae, lacking in newly ecdysed pupae but reappearing during adult development, and peaking in the reproducing adults. Weak reactivity to bombyxin antibody is confined to 3 pairs of medial brain cells in postfeeding larvae plus 2 pairs of ventral cord neurons in pharate adults, while in the reproducing adults it includes in the brain 1 pair of medial, 3 pairs of lateral, and 3 pairs of optic lobes neurons. Staining with allatotropin antiserum is high in fully grown larvae, undetectable in freshly ecdysed pupae, and maximal in reproducing adults. In larvae it occurs in 7 pairs of medial and 3 pairs of lateral brain neurons and in 6 pairs of ventral cord neurons; additional clusters of 10 brain neurons and 5 pairs ventral cord neurons are stained in the adults. Larvae carrying imaginal disc overgrowth mutations *dlg* or *dco* exhibit strong immunoreactivity for allatotropin, indicating that the pupariation inhibition in these larvae could be caused by enhanced JH production in response to superfluous allatotropin secretion.

#19

AN AMINO ACID DERIVATIVE RELATED TO THE INDUCTION OF EGG DIAPAUSE OF THE SILKWORM, *BOMBYX MORI*. Jun Yang, Koichi Suzuki (Faculty of Agriculture, Iwate University, Morioka 020, Japan)

Free amino acids in the brains of newly ecdysed pupae and the bodies of newly hatched larvae were examined in a bivoltine race (Daizo) of the silkworm, *Bombyx mori* by using high speed amino acid analyzer. An unidentified amino acid derivative was eluted between aspartic acid and threonine in the amino acid pool, which showed different concentrations with incubation conditions changed. The concentration in brains of the pupae which had experiened the regimen of high temperature (27°C) and continuous light throughout the embryonic developoment (HL-incubation), was 2.6-fold compared with that in the brains of pupae having experienced the regimen of low temperature (15°) and continuous dark (LD-incubation). The head or thoracic and abdominal parts of newly hatched larvae kept in HL-incubation also had a high content of the amino acid derivative. These results suggest that this substance might have a role in diapause induction.

#20

SPECIFIC PROTEIN RELATED TO DIAPAUSE OF THE PHARATE FIRST-INSTAR LARVAE OF THE WILD SILKMOTH, *ANTHERAEA YAMAMAI*. Hiroyuki Miura, Michiyoshi Takahashi, Koichi Suzuki (Faculty of Agriculture, Iwate University, Morioka 020, Japan), Eiichi Kuwano (Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Microsomal fractions of the pharate first-instar larvae of the wild silkmoth, *Antheraea yamamai*, were analyzed using both native PAGE and SDS-PAGE from the periods of diapause to diapause termination. The electrophoretic patterns showed that a protein which has appeared during diapause gradually decreased and finally disappeared before diapause termination. In native PAGE the mol. wt of this protein was about 400kDa while in SDS-PAGE it was about 150kDa.

This changes correspond to the activity of a repressive factor in pharate first-instar larvae which was reported by Suzuki *et al.* (1990).

#21

STUDIES ON BLOOD PHYSIOLOGY OF DIAPAUSE LARVAE OF NEODIPRION XIANGYUNICUS. Heng-xiao Guo, Jian-hua Zhou (Sichuan Academy of Forestry, Chengdu 610081, China)

The diapause of larvae and its blood physiology of Neodiprion xiangyunicus were studied in this paper. It's found that there is a diapause habit with larvae of Neodiprion xiangyunicus, and all larvae would be in diapause. There is a superficial diapause period of 15 days with mature larvae before becoming cocoons. There is a deep diapause period of 130 days with mature larvae in cocoons after it. It could be divided into two colour larvae with diapause larvae of superficial diapause period: orange colour and dark blue colour. There are about 26.96% and 73.04% in order, and each colour larvae can be divided into red and yellow this two blood colour.

The red and yellow blood of orange and dark blue colour larvae contain all 18 kinds of aminoacids. The aminoacid content of orange colour larvae is obviously higher than that of dark blue colour larvae with red and yellow colour blood, and the aminoacid content of two colour blood are obviously different with orange colour larvae. There is no obvious difference between two colour blood aminoacid content with dark blue colour larvae.

There is a quite variation about variety and content of two colour larvae and every colour blood in a colour, and orange color larvae is higher than dark blue with protein content of two color blood. The mature diapause larvae be divided into two kinds and four types according its physiological situation. They are: 1. orange colour larvae, 1A: orange larvae red blood type. 1B: orange larvae yellow blood type. 2. Dark blue color larvae, 2A; Dark blue red blood type. 2B: Dark blue yellow type.

#22

ECDYSTEROID TITRE AND OVARIAN DEVELOPMENT IN TWO BUGS WITH IMAGINAL DIAPAUSE. N.I.Kozhanova (Research Institute for Plant Protection, 18866 St. Petersburg, Russia), F.Sehnal (Entomological Institute CSAV, 370 05 Ceske Budejovice, Czechoslovakia)

Segregation and enlargement of ovarioles as well as the formation of functional oviducts in the last instar larvae of bugs are induced by the molt-inducing surge of ecdysteroids, and are not linked to a certain stage of oogenesis. Oocytes in the zygotene stage occur in *Pyrrhocoris apterus* and *Eurygaster integriceps* within 1-2 days of the last larval instar, but only in *P. apterus* they initiate cytoplasmic growth before imaginal ecdysis: in the larvae grown under long photophase (i.e. destined to give reproducing adults), the enlargement of oocytes coincides with the peak of ecdysteroid titre, whereas in those reared under short photophase (i.e programmed to render diapausing adults), with the ecdysteroid increase preceding the peak. Previtellogenesis begins under both regimes concurrently with the imaginal ecdysis. In the reproducing adults it is immediately followed by vitellogenesis, while in the diapausing females it continues slowly until maximal previtellogenic size; then the oocyte degenerates and is resorbed. In *E. integriceps*, which has an obligatory imaginal diapause, oocytes remain in the zygotene stage until about 5 days after emergence; they initiate cytoplasmic growth on day 8 and previtellogenesis is completed only at the end of diapause (no oocytes degenerate). Obviously, the rate and hormonal control of gonadal differentiation in the anticipation of diapause are species specific.

#23

HORMONAL CONTROL OF ADULT DIAPAUSE IN A STINK BUG, PLAUTIA STALI. Toyomi KOTAKI (Department of Insect Physiology and Behavior, National Institute of Sericultural and Entomological Science, Tsukuba, Ibaraki 305, JAPAN)

In a stink bug, Plautia stali short-day conditions induce adult diapause. To analyze the hormonal mechanism controlling the adult diapause, we examined the effects of surgical operations on diapause and measured the activity of corpora allata (CA) using an in vitro assay. Extirpation of CA or corpus cardiacum-corpus allatum complex (CC-CA) suppressed development of ovaries in females or ectadenia in males and induced reddish-brown coloration even under long-day conditions. In contrast, implantation of CC-CA into diapausing adults turned them green and induced development of the ovaries or ectadenia under short-day conditions. To assay the synthetic activity of CA, CA were incubated in a medium containing ^{3}H-Met and incorporation of the radiolabele into hexane-extractable substance(s) was measured. CA from diapausing females showed extremely low synthetic activity. TLC analysis revealed that the labeled compound(s) produced by active CA had lower Rf value(s) than those of standard JH I and JH III. These results suggest the possibility that diapause in P. stali is controlled through the activity of CA which produce substance(s) different from known JHs.

#24

PHYSIOLOGICAL CHARACTERISTIC OF ADULT DIAPAUSE IN TWO LADYBIRD SPECIES. Hironori Sakurai, Susumu Takeda (Laboratory of Entomology, Faculty of Agriculture, Gifu University, Gifu 501-11, JAPAN)

The ladybirds, Coccinella septempunctata bruckii Mulsant and Harmonia axyridis Pallas are very common aphidophagous species in Japan. The physiological characteristic of adult diapause was compared between both beetles. In summmer the metabolic activity and reproductivity of adults were suppressed completely in C. septempunctata, but partially in H. axyridis. Whereas in winter, the reproductivity was suppressed completely in the latter, while partially in the former, although the metabolic activity was suppressed considerably in both beetles. Electrophoretic analysis of haemolymph protein and treatment of juvenile hormone analogue demonstrated that the aestivation of C. septempunctata and the hibernation of H. axyridis are true diapause controlled by corpus allatum. Rearing experiment demonstrated that the summer climate is concerned with induction of diapause in C. septempuncta and the autumn climate does in H. axiridis. The difference of diapause type between both aphidophagous beetles might be attributable to the difference of life strategy adopted to existence of prey in each habitat.

#25

Purification and characterization of antibacterial and antifungal proteins from *Holotrichia diomphalia* (Coleoptera) larvae.

Lee, Bok Luel and Lee, So Young. Kyung-Sung Univ. College of Pharmacy 110 Daeyeun Dong, Nam-Gu, Pusan 608-736, Korea

Eight antibacterial proteins were induced when the body wall of *Holotrichia diomphalia* (Coleoptera) larvae was injected with live E.coli. These proteins were purified to homogeneity by several column chromatography. Among them, four proteins are specifically effective against gram positive bacteria. The molecualr weight of the these proteins was 4000-6000 and their partial amino acid sequence was determined. Four antifungal proteins were purified in the hemolymph of *Holotrichia diomphalia* larvae. They are effective against Candida albican. Their molecular weight was about 4,000. We have determined their partial amino acid sequences. We will discuss their characterization of these bio-active protiens.

#26

STUDIES ON LECTIN IN THE HEMOLYMPH OF LEUCANIA SEPARATA LARVAE. Chen-zhi Zhu (Department of Biology, Nankai University, Tianjin 300071, China), Yong Sun (Sinosys Development Co., Beijing100039, China), Zhen-heng Cheng (Department of Biology Nankai University , Tianjin 300071, China)

Hemolymph from Leucania separata larvae was found to agglutinate erythrocytes of human(B,O), rabbit, dog and cat. This agglutinating activity appears to be naturally occurring during development of insect and can be inhibited by fucose, lactose or neuraminic acid in vitro. A lectin was purified from the hemolymph of larvae by affinity chromatography on CNBr-Sepharose 4B column. The purified lectin showed three protein bands on polyacrylamide gel electrophoresis, and six subunits on SDS-polyacrylamide gel electrophoresis. The molecular weights of these subunits were 71,000 , 65,000 , 56,000 35,000 , 33,000 and 31,000 , respectively.

#27

HEMAGGLUTININ ACTIVITY IN THE HEMOLYMPH OF OSTRINIA FURNACALIS. Zhen-heng Cheng (Department of Biology , Nankai University, Tianjin 300071, China) , Yong Sun (Sinosys Development Co., Beijing100039, China)

Hemolymph of Ostrinia furnacalis was found to contain specific activity to agglutinate rabbit red blood cells. The specific activity of the hemagglutinin changed during development from fourth instar larvae to the pupal stage. This activity was specifically inhibited by D-galactose. The hemagglutinating activity can be induced to some extent by Beauveria bassiana and Saccharomyces cerevisiae. When the hemolymph sample was warmed up to 70° C for 15 minutes, its activity nearly reduced to zero. After long-time frosting, the activity can be reduced. Opsonic effect of this hemagglutinin was detected. The biological significance of its properties is discussed.

#28

HISTAMINE CONCENTRATION CHANGES DEPENDED ON PHASE POLYMORPHISM AND INFECTION IN THE CABBAGE MOTH *MAMESTRA BRASSICAE (LEPIDOPTERA, NOCTUIDAE)*. Alica Hučková, Mária Kazimírová, Milan Kozánek, Mirko Slovák, (Institute of Experimental Phytopathology and Entomology SAS, 900 28 Ivanka pri Dunaji, CSFR).

Using radioenzymatic method of Brownstein et al. (1974) histamine concentration in the haemolymph and the brain of the 6th instar solitary and gregarious phase larvae of *M.brassicae* was studied. A significantly higher histamine level ($p<0.05$) in both, haemolymph and brain, was found in gregarious phase larvae.

Further histamine concentration in the haemolymph of the intermediary form larvae infected on the 2nd day after moult into the 6th instar with entomopathogenous nemathods (*Heterorhabditis sp.)* was studied. 48 hours after infication histamine level was significantly higher in infected larvae compared to the control group. When larvae of solitary and gregarious form were infected histamine concentration increased significantly only in the solitary phase larvae.

Our results suggest that histamine might play a role in the insect defensive reactions against pathogens.

#29

SYSTEMIC RESPONSE OF PUMPKIN TO FEEDING BY SWEETPOTATO WHITEFLY. D.R. Jimenez, J.P. Shapiro, R.K. Yokomi, W.F. Osswald, R.T. Mayer (USDA, ARS, Horticultural Research Laboratory, Orlando, FL 32803, USA)

The cytology and physiology of pumpkin expressing squash silverleaf symptoms (SSL) as a result of Florida sweetpotato whitefly (*Bemisia tabaci*) feeding were examined to ascertain the etiology of SSL. Leaf silvering resulted from deformation in the palisade parenchyma at the adaxial epidermis. Internal organelles appeared normal, however, the thylakoid and envelope membranes appeared deteriorated and the vascular bundle in SSL-affected tissue displayed apposition and vesiculation at the plasmalemma. Silvered tissue exhibited 40-50% reduced total chlorophyll and two proteins estimated at 31K and 70K Mr were induced in the intercellular fluid (IF). Pooled IF proteins from silvered tissue exhibited lower levels of chitinase and peroxidase activities. Chlorotic spots on the leaf at the feeding site of mature *B. tabaci* nymphs were associated with empty mesophyll cells. Cell walls were intact but the plasmalemma was degenerate and vesiculation ubiquitous. Chloroplast starch granules were absent and the stoma contained numerous osmiophilic granules. Sieve and xylem elements were open. These symptoms were similar to that of premature senescence induced by phytotoxic *Shizaphis graminum*. Anatomical and physiological evidence suggests that SSL is a phytotoxic response to *B. tabaci* feeding. No evidence of a virus or viruslike agent was found in SSL-affected plants.

#30

THE EFFECT OF HOST PLANTS ON THE METABOLISM OF COTTON BOLLWORM I. THE VARIATIONS OF DEVELOPMENT AND CONTENTS OF PROTEINS AND AMINO ACIDS OF LARVAE. Wei-jia Tan, Xue-mei Yang, Yu-yuan Guo (Institute of Plant Protection,Chinese Academy of Agriclutural Sciences, Beijing 100094,China)

Several host plants were fed separately to cotton bollworm Heliothis armigera (Hübner) after hatching and the effects of different host plants on the growth and metabolism in different stages of this insect pest were determined. The results showed that the host plants obviously induced the changes of its growth and metabolism, which were most significant in the third instar. Although the increase tendencies of larval weights from different host plants were similar, the duration of larval development were evidently different. The analysis results of the contents of proteins and free amino acids showed that all the larvae possessed seventeen free amino acids with main components Glu, Tyr and Arg. The fact that the increase of larval weights was not in direct proportion to the increase of proteins and amino acid contents suggested that this phenomenon is possibly related to the action of secondary substances in host plants or the defensive function of cotton bollworm.

#31

INFLUENCE OF CHINESE MEDICA ON ERI-SILKWORM VITALITY. Ting-yin Liu(Institute of serieulture, Hebei Academy of Agrieurture and Forestry sciences, Chengde 067000, China) Hu-zhan Zheng, Zheng-hua Yan, Wen-wei Chen(Beijing college of traditional chinese medicine, Beijing 100029, China)

After eri-silkworm had been fed with castor leaves sprayed with 20% water decocting solution of PNEBIBC(prescription of nourishing essence and blood, and invigorating blood circulation), the following results were observed:(1) Eri-silkworm's adhesive force was notably enhanced, $P<0.01$; (2) Hatchability was obviously raised, $P<0.05$; (3) Metabolic number was reduced; (4) Activity of Hydrogen Peroxidase in pupa blood lymph was increased, $P<0.01$. These outcomes indicate that Chinese Material Medica can improve silkworm's physique, prevent and cure silkworm disease. This offers useful data for us to use Chinese Material Medica to prevent and cure human's disease, improve human's physique, and to postpone senility of human being. The method for determining eri-silkworm adhesive force, which was used firstly, can also be used to investigate the physical strength of other insect larva.

#32

EXTRACTION, SEPARATION AND IDENTIFICATION OF ATTRACTING COMPONENTS FROM PLANT TO CYLAS FORMICARIUS FABR. Jian-xin Chen(Beijing Agricultural University, Beijing 100094,China), Mei-ying Chen(University of Wisconsin, Madison, U.S.A.)

For searching and developing bioactive materials with attracting property to sweet potato pest, Cylas formicarius, the authors have made a series of efforts on extraction, separation and bio-assay of the active compositions from the host plants-- sweet potato and morning glory, and from the non-host-- potato. Some of the active ingredients, separated and identified by gas- and layer chromatography, are umbelliferine, coumarin and scopoletin according to the sequence downwards of their attracting effectiveness to the weevil.

#33

THE EFFECT OF HOST PLANTS ON THE METABOLISM OF COTTON BOLLWORM II. THE CHANGES OF ACTIVITY OF MIXED FUNCTION OXIDASE AND CARBOXYLESTERASE. Wei-jia Tan, Xue-mei Yang, Yu-yuan Guo(Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094,China)

The effect of host plants on the metabolism of cotton bollworm was determined by biochemical methods. The results showed that the highest activities of mixed function oxidase and carboxylesterase all appeared in third instar larvae (40-70 mg), it decreased with the advanced development of larvae and the lowest activity was in pupa stage. The activities of both enzymes in cotton bollworm fed on pepper fruits were highest, and the most significant differences among the larvae fed on five host plants separately were in the third instar. It is suggested that the third instar is possibly the key period that host plants effecting on the metabolism of cotton bollworm, and the effects were different among various host plants.

#34

HOST PLANTS AND DIETARY PROOXIDANTS AFFECT ANTIOXIDANT ENZYMES IN ONION AND SEEDCORN MAGGOTS, *Delia antiqua* and *D. platura*. Yukio Ishikawa (Faculty of Agriculture, The University of Tokyo, Tokyo 113, Japan)

Effect of host plants and dietary prooxidant chemicals on antioxidant enzymes, i.e., Superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPOX), was studied in the onion and seedcorn maggots, *Delia antiqua* and *D. platura*. SOD activity of *D. platura* was 1.7 times that of *D. antiqua* when the two species were grwon on a synthetic diet devoid of plant secondary compounds. SOD activities of the two species feeding on respective host plants were 100 - 230 % greater than those of larvae feeding on the synthetic diet. Synthetic diet containing up to 0.1 % of quercetin, a prooxidant chemical present in onion bulbs, elicited no increase in SOD activity, though SOD increased ca. 2.5 times in both species when the concentration was raised to 1.0 %. CAT levels were very high, being unaffected by the diet or the addition of quercetin in both species. Effects of 18 other prooxidant chemicals on the growth of larvae and the activities of antioxidant enzymes were also examined.

#35

USE OF P^{32} RADIOTRACER FOR ESTIMATING PLANT INFESTATION BY LEAFHOPPERS AND APHIDS. JUDY JU-HU CHIANG AND ROBERT KUO-CHENG CHEN.(Department of Entomology, National Chung-Hsing University, Taichung, Taiwan 40227, China)

This research measures the rate of uptake of P^{32} as phosphate in sucrose solutions and its biological half-life in aphids and leafhoppers. The relationships among effective, physical and biological decay in these insects are analized. When the dietary requirements of leafhoppers and aphids are defind, it becomes possible to make predictions about the susceptibility of the host plants to these insects. When the uptake rate is measured, predictions can be made on the distribution and abundance of leafhoppers and aphids on host plants, based on the decreasing levels of certain nutrients in the plant sap.

#36

HOST PLANT RESISTANCE OF CORN TO ORIENTAL CORN BORER, Ostrinia furnacalis GUENÉE : Two antibiotic factors affect on the larval development. Osamu Saito (Hokkaido Natl. Agric. Expt. Stn., Sapporo 062 Japan)

Corn plant at the vegetative growth stage contains two type of resistant substances which inhibit larval development of the oriental corn borer, Ostrinia furnacalis GUENÉE. One is a cyclic hydroxamic acid, DIMBOA(2,4-dihydroxy-7-methoxy-1,4(2H)-benzoxazin-3-one) which is well known as a resistant factor of corn plant to the European corn borer. Another is the nitrate nitrogen which is a important nutrient and is deposited in active growing parts of the plant.

The artificial diet containing certain concentration of DIMBOA, MBOA(6-methoxybenzoxazolinone, autolitic product of DIMBOA) and nitrate were prepared and the corn borer larvae were reared on the diets to observe the developmental response. From the results, these resistant substances had antibiotic effects, but they didn't have the effect as feeding deterrent. The antibiotic effects were appeared as decrease in the larval survivorship, prolongation of the larval period and decrease in the larval and pupal weight.

#37

ANALYSES OF AMINO ACIDS IN THE HONEYDREW AND FOOD OF PARACEROSTEGIA JAPONICUS (GREEN) Jucai Han, Huiping Liu, Fangte Tang (Department of Plant Protection, Shanxi Agricultural University. Taigu, Shanxi 030801, China)

The present paper analyzes 17 amino acids in the honeydrew and food of Paracerostegia japonicus (Green) feeding on jujube trees and persimmon trees. The result shows that no matter the scale insects feed on jujube trees or persimmon trees, the honeydrew excreted by them contains all of the 17 amino acids. But on different hosts, the relative contents of each amino acid in the honeydrew are different. In its food all the 17 amino acids, but sometimes cyctine, are found. According to the relative contents of each amino acid in honeydrew and food, It is concluded that when the scale insects feed on jujube trees, much more proline, serine, alanine, valine, isoleucine and phenylalanine in food are utilized. but when it feeds on persimmon trees. more serine, lysine, aspartic acid, threonine glutamic acid, proline, glycine, alanine and methionine in food are ultilized. Some other amino acids may not be used at all.

#38

RESPIRATORY METABOLISM AND POPULATION ENERGY RESPIRATION OF GRASSHOPPER CHORTHIPPUS DUBIUS(ZUB.). Xing-hui Qiu, Hong-chang Li(Institute of Zoology,Academia Sinica, Beijing 100080,China)

Respiration rates of Chorthippus dubius(Zub.) were determined by use of an infrared carbon dioxide analyzer at different temperatures. All 5 instars and both sexes of adult were investigated. Results of regression analyses of body weights(dry) vs.oxygen consumption at 10-30°C gave slope values ranging from 0.75-0.87. And regression analyses of oxygen consumption rates per unit of body weight showed that Krogh's formula could be applied to the individuals at 2nd or 3rd instar stage and Arrhenius' equation at the other stages. No statistically significant difference in diurnal and nocturnal respiration rates at the same temperature was observed.

According to the regression equations between oxygen consumption and temperature, coupled with the observations of population biomass and mean ambient air temperature, we computed the oxygen consumption by the relative population in the three plant communities. The Wightman's coefficient of 2.58 was adopted to correct the population oxygen consumption value, considering the difference of respiration of the animal in lab and in field. An oxycaloric coefficient of 4.83 (cal./ml) was used to convert the oxygen consumption to calories. This resulted in the population respiration of 4.65KJ in Aneurolepidium chinense+Stipa grandis+Agropyron michnoi community, 3.99KJ in Artemisia frigida community and 2.33KJ in Aneurolepidium chinese community.

#39

THE DIFFERENCE OF MDH ISOZYME GENE FREQUENCY IN 3 SUBSPECIES OF *APIS MELLIFERA* . Ju-huai Li (Beijing Academy of Agriculture and Forestry Sciences, Beijing 100081, China), Shao-wen Li, Xiao-jing Wang, Jing-wei Xiao (Department of Biology, Peking University, Beijing 100871, China)

Electro-focusing PAGE method was used to study MDH (Malate dehydrogenase) isozyme gene frequency variations among 3 subspecies of *Apis mellifera* -- *A. m. ligustica, A. m. carnica* and *A. m. carpatica,* 106, 107, 103 adult female workers were used in each subspecies. Electromorphs in 3 subspecies are divided into three zones. In these zones MDH II is encoded by three alleles: a, b and c. There are six genetypes: three homozygotes(a/a,b/b and c/c) and three heterozygotes(a/b,a/c and b/c). There are distinct variations in gene frequency among 3 subspecies. In *A. m. ligustica* gene b frequency covers 19.81%, it is higher than in *A. m. carnica* (6.08%) and *A. m. carpatica* (0.97%). In *A. m. carnica* gene c frequency covers 82.71%, it is higher than in *A. m. ligustica* (74.05%) and *A. m. carpatica* (64.57%). In *A. m. carpatica* gene a frequency covers 34.47%, it is higher than in *A. m. carnica* (11.22%) and *A. m. ligustica* (6.13%). There are also homozygote scale variations among 3 subspecies, the highest is in *A. m. carnica* (76.64%), the second in *A. m. ligustica* (65.09%) and the lowerest in *A. m. carpatica* (49.52%).

#40

STUDY ON ISOZYME SYSTEMS OF THE SPECIES COMPLEX OF Anopheles minimus Theobald (Diptera:Culicidae) IN VIETNAM. Trinh Dinh Dat,Truong Quang Hoc and Ngo Giang Lien (Faculty of Biology,University of Hanoi, Hanoi,VIETNAM)

7 isozyme systems of single families of An.minimus complex were investigated by polycrylamid gel electrophoresis.The ODH and MPI systems can be used for detecting different forms and species of An.minimus complex and it's related species. Allele frequencies of the loci Odh and Mpi of the An.minimus complex were detected,a percentage of which vary from location to location.There are two interspecific variations in An.minimus complex in Vietnam.

The electrophoretic results do not completely correlate to the present morphological classification.

#41

PEROXIDASE AND CATALASE IN HEMOCYTES OF BLACKFLY, WILHELMIA SALOPIENSIS EDW., DURING PREIMAGINAL DEVELOPMENT. V.Y.Dvornik (Department of Zoology, Donetsk State University, ul. Universitetskaya, 24, Donetsk 340055, Ukraine)

Using methods with o-tolydine as a substrate it has been showed that 4 types of the hemocytes (prohemocytes, micronucleocytes, plasmatocytes and granular hemocytes) contained both peroxidase and catalase but adypocytes contained only catalase. There are two types of micronucleocytes which have different localization of peroxidase and probably fulfil different physiological functions. The highest level of peroxidase activity was observed in the hemocytes of prepupa, 2-3-day-old and 4-5-day-old pupae whereas catalase manifested its highest activity in the prepupa and 3-4-day-old pupa. Probably the peroxidase and catalase activitiés in the prepupa are connected with detoxification of metabolic products, but in the pupa - with processes of cuticular formation.

The obtained data make it possible to suppose that during the preimaginal development the most probable way of cellular transformations in the morphofunctional genesis of blackfly hemocytes is: prohemocytes - micronucleocytes - plasmatocytes (phagocytes).

#42

THE FUNCTION AND CHARACTERIZATION OF LACTIC DEHYDROGENASE (LDH) AND OF LDH-INHIBITOR IN THE LARVA OF *CULEX PIPIENS MOLESTUS*. Kyoko Sawabe (Department of Parasitology and Tropical Public Health, University of Occupational and Environmental Health, Yahata-nishi-Ku, Kitakyushu 807, Japan)

LDH activity in mosquito larvae, except in *Cx.pipience* group can be easily detected on the polyacrylamide gel electrophoresis (PAGE) by the reaction using lactate and NAD^+. In previous studies it was found that this species has a large amount of LDH-inhibitor in the digestive tract. The present study is attempted to demonstrate the relation between LDH and LDH-inhibitor.

The LDH-inhibitor of *Cx.p.molestus* was detected in the gastric caeca and midgut. After the PAGE followed by the SDS-PAGE, this inhibitor was separated into 2 fractions. The low molecular weight protein showed trypsin-like activity. LDH activity of this species could be detected by the reverse reaction using pyrvate and NADH. Namely, this reaction using pyrvate to lactate. For availability of NAD-NADH in this mosquito, the activity of α-glycerophosphate dehydrogenase (α-GPDH) was much higher than that of LDH. The comparative activity of α-GPDH to LDH was the highest among 6 species. Similar results were also observed in another autogenous species *Aedes togoi*. These results suggest that such autogenous mosquitoes produce much glycerol than lactate by the presence of LDH-inhibitor.

#43
ACTIVITIES OF DIGESTIVE ENZYMES IN DIFFERENT PARTS OF THE GUT OF THE HOUSE CRICKET. Leng-Hong Teo (Department of Zoology, National University of Singapore, Kent Ridge, Singapore), J. P. Woodring (Department of Zoology, Louisiana State University Baton Rouge, Louisiana, U.S.A.)

The activity levels of six different digestive enzymes in five different parts (foregut, caecum, ventriculus, ileum, rectum) of the gut of the house cricket were assayed under the pH condition of each part of the gut in order to determine the contribution of each part of the gut to the digestion of various substrates. The foregut, with its acidic contents, showed the highest activities in amylase, sucrase, trehalase and maltase. Ileum, with its neutral contents, showed the highest activities in amylase, sucrase and lipase. Ventriculus, also with neutral contents, only showed the highest activity in protease. Although caecum was the main site of enzyme secretion, it only occupied the second position in the activities of amylase, sucrase and lipase. The foregut was the most important site of digestion in the house cricket.

#44
PURIFICATION AND PROPERTIES OF THE CELLULASE OF *PANESTHIA CRIBRATA* SAUSSURE, AN AUSTRALIAN WOOD-EATING COCKROACH. A. M. Scrivener and M. Slaytor (Department of Biochemistry, The University of Sydney, Sydney, N.S.W. 2006, Australia)

The Australian native cockroach, *Panesthia cribrata* feeds exclusively on rotting timber but may be maintained indefinitely in the laboratory on crystalline cellulose. Previously, we have demonstrated that *P. cribrata* secretes an endogenous cellulase which is present in the foregut and midgut. Cellulase components were separated by molecular sieve and hydrophobic-interaction chromatography. Two β-1,4-glucosidase components of similar molecular weight were present, the major component contributing 90% of the total activity. These components showed little difference in substrate specificity between cellodextrins from cellobiose to cellopentaose. They were also active against *p*-nitrophenyl-β-D-glucopyranoside and showed transglycoslyase activity. The major β-1,4-glucosidase was inhibited by cellopentaose at concentrations above 6 mM; other cellodextrins and glucose were not inhibitory. Glucono-δ-lactone was a potent inhibitor. There were seven endo-β-1,4-glucanase components, three major (90%), low molecular weight and four minor high molecular weight components. The major components were active against cellotetraose and cellopentaose and inactive against cellobiose and cellotriose; they produced cellobiose from cellotetraose, and cellobiose and cellotriose from cellopentaose. They showed negligible activity against crystalline cellulose. Increasing activity was demonstrated with increasing cellodextrin chain length up to cellopentaose and all substrates were inhibitory at concentrations above 6 mM.

#45
THE MALTASE ACTIVITY IN THE HOUSE CRICKET ACHETA DOMESTICUS L. Leng-Hong Teo (Department of Zoology, National University of Singapore, Kent Ridge, Singapore 0511) J. P. Woodring (Department of Zoology, Louisiana State University, Baton Rouge, Louisiana, U.S.A.)

The maltase activity was highest at pH 5.6 and so it is well adapted to the pH condition of the foregut only. Under optimal pH and incubation time of one hour, maltase activity was highest at 40° C. Arrhenius plot gives an estimation of activation energy of 5,300 cal/mole. The 50% inhibition concentration of mercuric chloride was 163 umole and the 50% inactivation time at 50° C was 69 min. Five days of starvation caused a decrease of 55% of the total activity of the whole gut. When determined under optimal pH, the caecal tissues showed a high maltase activity whereas in other regions of the gut, the activities of maltase were only detected in the lumen with the highest activity in the foregut. The caecum and ventriculus contained only about one-third of the foregut activity.

#46
CHANGES IN THE ACTIVITIES OF ENZYMES ASSOCIATED WITH LARVAL AND PUPAL ECDYSIS OF DUSTY BROWN BEETLE. Jyoti Dwivedi, O.P.Agrawal (School of studies in Zoology, Jiwaji University, Gwalior 474011, India)

The activities of chitinase using colloidal chitin and chitosan and protease using bovine serum albumin as substrates have been determined spectrophotometrically in the whole body extracts of dusty brown beetle, Gonocephalum species from last instar larvae to adult emergence. The activity profile has revealed that the rise in the activities of both the enzymes was preceded with moulting process. The peak of the protease activity was found to occur little earlier than that of the chitinase activity. This indicates that first the proteolosis is necessary to remove (unmask) the bound proteins before the cuticular chitin could effectively be digested by chitinolytic enzymes. Further, Sufficient chitinase activity was observed to remain associated with exuviae and in pellet after extraction. Thus the enzyme appears to bind with the deproteinized cuticle.

#47
PROPERTIES OF ECDYSONE 20-MONOOXYGENASE IN SPODOPTERA LITTORALIS. Jian-Hua Chen[1], J. Shergill[2], M.J. Fisher[1], R. Cammack[2] and H.H. Rees[1] ([1]Department of Biochemistry, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, U.K.; [2]Division of Biomolecular Sciences, King's College London, Campden Hill Road, London, W8 7AH, U.K.)

In insect larvae, production of ecdysteroids in the prothoracic glands yields ecdysone in the haemolymph. This undergoes C-20 hydroxylation catalysed by the cytochrome P-450-dependent ecdysone 20-monooxygenase in certain peripheral tissues, yielding the major, active ecdysteroid, 20-hydroxyecdysone. The properties of ecdysone 20-monooxygenase from Spodoptera fat body have been examined. This enzymic activity is primarily mitochondrial and exhibits a distinct peak during development in the sixth instar. Components of the electon transport chain transferring electrons from NADPH to cytochrome P-450 have been examined by a variety of techniques, including electron spin resonance and immunoblotting. Cross-reactivity of specific proteins was observed with antibodies raised against certain vertebrate cytochrome P-450s and adrenodoxin. The quantitative variation in abundance of these proteins correlated with changes in ecdysone 20-monooxygenase activity during development. Using the foregoing probes, the molecular basis of the long-term control of the changes in monooxygenase activity has been investigated, including effects of induction by ecdysteroids and of RNA and protein synthesis inhibitors.

#48
PURIFICATION, PROPERTIES AND INTRACELLULAR LOCALIZATION OF ESTERASES FROM CABBAGEWORM, PIERIS RAPAE L. Sung Moon Yoe, Chul Ho Park, Do Seon Lim (Department of Biology, Dankook University, Cheonan 330-714, Korea), Hak Ryul Kim (Department of Biology, Korea University, Seoul 136-701, Korea)

Three esterases (E2, E6 and E11) from the late fifth instar larvae of Pieris rapae L. and the properties of these esterases were purified and determined, and physiological role of E6 was inferred using immunological methods. Purification of esterase was performed using gel filtration on Sephadex G-100, ion-exchange chromatography on DEAE-Trisacryl and preparative electrophoresis. The final purities of these enzymes were about 30 to 60-fold. Based on inhibitor study, all of the purified esterases were found to be carboxylesterases (EC 3.1.1.1). The molecular weights of E2, E6 and E11 were estimated to be 42 KD, 81 KD and 174 KD, respectively. The isoelectric points of E2, E6 and E11 were estimated to be pH 5.54, pH 5.89 and pH 6.50, respectively. The concentration of E6 during development was highest at the late fifth instar larval stage and that according to organs at the same stage was highest in the midgut. These results suggest that E6 might be a hydrolase involved in the digestion of dietary lipids.

The localization of the midgut esterases during the fifth larval period was observed with cytochemical treatment using transmission electron microscope. The esterase activity occured in the protoplasmic processes of the goblet cells and in the microvilli of the columnar cells.

#49

ENERGY CHARGE IN DIFFERENT MORPHS OF APHIDS. Roberto Crema, Lorenzo Bolognani and V.. Del Monte, Dipartimento di Biologia Animale, Università di Modena, Modena, Italy.

The concept of"Energy Charge", expressed by the formula: E.C. = [ATP] + 1/2 [ADP] /[ATP] + [ADP] + [AMP] and the single levels of ATP,ADP and AMP are of particular interest in Aphids owing to the group polymorphism involving different energy requirements in various stages and morphs. ATP, ADP and AMP were extracted from pooled specimens of *Acyrthosiphon pisum*(Harris) cultured on *Vicia faba* at 17 C° and 16 h light/day. Analyses were performed on synchronous batches (1-10 days and older) of larvae and adult *alatae* and *apterae*. Newly emerged 10 days old *alatae* contain higher ($p<0.01$) [ATP] than *apterae* (2.28±0.25 and 1.62±0.36 nmoles.mg $^{-1}$ respectively). [AMP] and [ADP] increased with aging thus causing lower E.C. values in adults and aged aphids. E.C. of 10 aged *apterae* and *alatae* are, contrary to [ATP], similar. This depends on relatively lower values of nucleotide utilization with respect to synthesis (lower [AMP] and [ADP]) in *apterae*. The newly emerged 10 days *alatae* have higher [ATP] concentration and similar E.C. probably dependent on the extremely active winged apparatus. This agrees with highest [ATP] and both [ADP] and [AMP]. Old *alatae* present a sharp decrease of [ATP] and E.C. due to evident degradation of [ATP] and highest [ADP]. This concomitantly with the lower mobility after the migratory stage and settlement in the new host plant.

#50

VARIATION OF FREE AMINO ACIDS IN THE BRAIN OF MUSCA COMESTICA DURING ADULT DEVELOPMENT. Ying-chun Ouyang, Zong-shun Wang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

In order to find out the correlation between the change qualitatively and quantitatively in free amino acids and brain function, twenty amino acids in the brain of adult housefly Musca domestica at different ages were measured. Two rearing methods of the adult housefly had been employed: mixed sex and separated sex. It was found that the concentrations of total free amino acids were higher in female than in male, the average levels were 35.82 nmol/brain (mixed), 38.19 nmo/brain(separated) in female, and 29.16 nmol/brain (mixed), 32.57 nmo/brain(separated) in male. The contents of Asp, Glu, Gly, Ala, His, Arg, Cys, GABA, Pro, Hypro and Tau were higher than other amino acids. Among the amino acids mentioned above, the increase of Glu, GABA, Pro and Ala was more evident in the separated sex rearing than in mixed sex rearing. The concentrations of Glu, GABA (as neurotransmitters) and Pro, Ala (as energy amino acids) were much higher in female than in male in both cases, especially the level of Ala in separated sex rearing was about twice as much as that in the mixed sex rearing at day 15 after eclosion.

#51

DEVELOPMENT AND PROTEIN SYNTHESIS OF THE COLLETERIAL GLANDS IN THE SILKWORM,BOMBYX MORI. Katsuhiko Yoshida,Hajime Fugo (Department of Environmental Sciences and Resources,Tokyo University of Agriculture and Technology,Fuchu,Tokyo 183),Tadasu Mori (Kinjou University,Nagoya),Nobuyuki Arisawa (Nissan Chemical Industries,Saitama,Japan), Xiang Yao (Suzhou Institute of Sericulture, China).

Development and protein synthesis in the colleterial glands of the female silkmoth were investigated. The weight of the glands increased lineally up to the adult eclosion ,and then decreased with age. The protein content in the glands increased in parallel with the change of the weight of the glands. On day 6 of pupal-adult development, the RNA content in the arborescent regions of the glands increased rapidly, then dropped after eclosion. High rates of the incorporation of labelled amino acid (C-U-leucine)into the protein fractions were observed in the arborescent regions. The electron-microscopic observations showed the high density of the secretory materials was found in the cells of the arborescent regions. The proteins corresponding to the glue proteins were secreted from the arborescent regions of the glands in vitro. These results indicated that the arborescent regions were the source of the protein synthesis. The characters of the glue proteins synthesized at the arborescent regions will be discussed.

#52

STUDIES ON THE STORAGE PROTEIN OF HYPHANTRIA CUNEA DRURY. Sook Jae Seo(Department of Biology, Gyeongsang National University, Chinju, Korea), Hak Ryul Kim(Department of Biology, Korea University, Seoul, Korea)

76.7Kd protein in Hyphantria cunea has property of storage protein. Like fat body, which is the primary site of storage protein synthesis, Malphigian tubules and testes synthesize this storage protein. This protein in both testes and fat body is produced at high levels within 1hr to 5hr following heat treatment. Immunocytochemical studies using an antiserum reveal the accumulation of storage protein into the nucleus in spermatocyte of heat treated testis. Like heat shock protein, this storage protein seems to play a vital role in survival of cells under environmental stress.

#53

PROTEINS SYNTHESIZED IN RESPONSE TO HEAT SHOCK OF CULTURED CELLS OF THE MOSQUITO, AEDES TRICERIATUS. Yang Wu[1], Guy Charpentier[2], and Robert M. Tanguay[1]. ([1]Insect Biotech Canada, Laboratoire Génétique Cellulaire et Moléculaire, CHUL, Ste.-Foy, Qc, Canada, G1V 4G2; and [2]GRIP, Dep. Chimie-Biologie, UQTR, Trois Rivières, Qc, Canada).

Protein synthesis during heat shock of cultured cells of the dipteran, Aedes triceriatus, (lines ATB, ATC, and ATIV), was studied by protein labelling and immunoblotting. Cells were heat-shocked at 33°, 35°, 37°, or 39°C. (Control temperature was 23°C.). All three cell lines exhibited the heat shock-induced synthesis of proteins with molecular weights of approximately 83, 70, and 27 kDa. While both the 83 and 27 kDa heat shock proteins (hsps) were induced at 33°, the major 70 kDa hsp of these cells was not induced unless cells were heat-shocked at 37° or 39°C. Two-dimensional electrophoretic analysis revealed that the 70 kDa hsp consisted of several isoforms. Antibodies to Drosophila hsp83 and to human hsp89 both recognized an 83 kDa protein in both control and heat-shocked mosquito cells. The mosquito hsp27 did not cross-react with antibodies to either Drosophila hsp27 or hsp26, or to human hsp27. An antibody to a Drosophila 70 kDa heat shock cognate cross-reacted with a mosquito hsp70 that is constitutively synthesized. Antibodies to human hsp70 cross-reacted to a heat shock-induced isoform of mosquito hsp70. Cell fractionation studies revealed that this heat shock-induced mosquito hsp70 is cytoplasmic.

#54

THE HEAT SHOCK RESPONSE OF THE CONIFEROPHAGOUS SPRUCE BUDWORM: PRESENCE OF A NOVEL 77 kDa MAJOR HEAT SHOCK PROTEIN. Robert M. Tanguay, Timothy W. Blaker and Raquel Marin. (Insect Biotech Canada and Laboratoire de Génétique Cellulaire et Moléculaire, Centre de Recherches du CHUL, Ste-Foy, Qc., G1V 4G2 CANADA).

Spruce budworm *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae) is a conifer-feeding insect that develops periodic outbreaks and causes considerable tree mortality. Among the numerous factors that affect budworm populations, fluctuations of the temperature regime may play an important role in this insect's survival and development.

To gain insight on the different stress responses of *Choristoneura fumiferana*, we have studied the heat shock response of an established cell line (line CF_1) by exposing cells to different temperatures (35, 37, 39°C) followed by labelling with ^{35}S-methionine at their normal growth temperature (23°C). Proteins were analysed by SDS-PAGE, two-dimensional gel electrophoresis and by immunoblotting with antibodies made against the hsps of *Drosophila melanogaster*. Apart from the highly conserved hsp 89 and 70, CF_1 cells have a major hsp (77 kDa) that is not seen in dipterans. On 2-D gels, hsp 77 is shown to consist of at least four distinct isoforms. An equivalent hsp 77 is shown to be present in heat-shocked cells from the lepidopteran *Spodoptera frugiperda* (SF_9 cells). The 77-kDa hsp did not show any cross-reactivity with the different anti-hsp 70 antibodies used. Two-dimensional electrophoretic analysis of *in vitro* translated poly(A)$^+$ RNAs extracted from control and heat-shocked cells showed that all the isoforms of the 77 kDa hsp are newly synthesized in heat-shocked cells. These mRNAs are being used to construct cDNA libraries for control and heat-shocked cells. Further studies on the heat shock response of *Choristoneura fumiferana* should be a valuable asset to our understanding of the effects of temperature on this pest insect and may help in its genetic control.

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#55

JUVENILE HORMONE BINDING PROTEINS OF THE RED COTTON BUG, *DYSDERCUS CINGULATUS*

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Although studies to clarify the role of juvenile hormones (JHs) in regulation of metamorphosis were performed on the Heteropteran *Rhodnius prolixus*, the existence of juvenile hormones in bugs has not been cleared so far. However Heteroptera species reacts very sensitively for application of JHs.

One of the possible way to get evidences for the presence of JHs in these species is to identify certain proteins could be selectively labeled by using diazo-JH-analogues. Using SDS-PAGE and fluorography specific juvenile hormone binding proteins (JHBPs) were identified from hemolymph samples incubated with *[^{3}H]-epoxyfarnesol-diazoacetate (EFDA)*, the diazo analogue of JH III. Although both in larval and in adult (male and female) hemolymph a few low molecular weight proteins could be labeled with the EFDA, the EFDA binding of a 29.0 kDa (in females) and a 22.4 kDa (larval, male and female) proteins could be inhibited by adding JH III in 100 fold excess. The hemolymph of adult females (in the third day after molting to adult) contains a very high molecular weight (about 100 kDa) specific JHBP, which does not exist in males and larvae. The properties and function of this protein has not been cleared yet, however, it is likely that, as in *Leucophaea maderae*, this JHBP is nothing else than the vitellogenin itself.

#56

JUVENILE HORMONE BINDING PROTEINS AND RECEPTORS IN LOCUST FAT BODY.

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^{3}H-10R-JHIII, prepared by biosynthesis in cockroach corpora allata, has been used to study binding in nuclei and in protein extracts from fat body of adult female Locusta migratoria, a tissue in which juvenile hormone (JH) regulates the expression of vitellogenin and some other genes. Binding of the natural enantiomer of JHIII is 80-90% specific (competed by 100-fold excess of unlabelled racemic JHIII). Protein extracts contain a major, lower affinity component and a minor, higher affinity component with k_Ds in the nM range, which have different molecular characteristics and can be separated by chromatography. The JH analogs, ^{3}H-methoprene and ^{3}H-pyriproxyfen (given by Dr. G.D. Prestwich), also bind abundantly to locust fat body nuclei, but only 30% or less of this binding is competable by 100-fold excess of the respective ligands. Binding of JHIII is competed by very high levels of pyriproxyfen. The JH binding components are being characterized in order to determine their relationships to the different ligands and their roles in JH action. (Supported by Insect Biotech Canada.)

#57

Studies on the Juvenile Hormone Titer and Juvenile Hormone Binding Protein in the Chestnut weevil, Curculio dentipes Roelofs

Kyung-Ro Lee (Dept. of Biology, Kon-Kuk Univ. Seoul 133-701, Korea)

The juvenile hormone titer showed the highest activity at the non-overwintering larvae(22,600GU/g) whereas it reached the lowest level at the pupal state(600GU/g) through the prepupal stage. The activities of the juvenile hormone specific esterase from homogenates peaked at the wintering larval and the prepupal stage. The activity of the juvenile hormone specific esterase per mg of total protein was the lowest at the non-overwintering larvae(0.4305 n mol/min/mg) and it increased at the wintering larvae, but reduced at the overwintering larvae. Finally, it reached the maximm at the pupal stage(1.3256 n mol/min/mg). Two juvenile hormone binding proteins were detected. One was juvenile hormone binding lipoprotein (JHLP, Mr 60,000 - 70,000 daltons), and the other was juvenile hormone specific binding protein (JHBP, Mr 30,000 - 35,000 daltons). The relationship between juvenile hormone titer and juvenile hormone specific esterase was an inversely proportional. Total protein and capacity of juvenile hormone binding protein also was related to the same aspect. These data indicated that high juvenile hormone level at the non-overwintering larval stage induced the diapause and prolonged the diapausing period during the larval stage. And also, high juvenile hormone esterase activity and juvenile hormone binding capacity at the prepupal stage induce the normal larval-pupal ecdysis.

#58

JUVENILE HORMONE BINDING PROTEIN FROM HEMOLYMPH OF HYPHANTRIA CUNEA

In-Hee Lee and Hak-Ryul Kim (Department of Biology, Korea University, Seoul 136-701, Korea)

Juvenile hormone binding protein (JHBP) was purified by polyethylene glycol (33%) precipitation, DEAE cellulose ion exchange chromatography, gel filtration (Sephadex G-200 and G-50), preparative electrophoresis and chromatofocusing. The homogeniety of purified JHBP was confirmed by analytical electrophoresis and electron microscopy. The molecular weight and isoelectric point of JHBP was revealed using calibrated gel filtration column and electrofocusing. Also, antiserum against JHBP was employed to compare the relative concentration of JHBP during development and to confirm immunological relationship between JHBP and lipophorin.

#59

PROLIFERATION OF CORPUS ALLATUM CELLS IN *DIPLOPTERA PUNCTATA* ADULTS.

Ann-Shyn Chiang, Glenn L. Holbrook and Coby Schal (Department of Entomology, Cook College, Rutgers University, New Brunswick, NJ 08903, U.S.A.)

The role of corpus allatum (CA) cell proliferation in the production of juvenile hormone in adult cockroaches has received much attention but with little consensus among researchers. Previous studies, based on cell counts from sections of fixed glands, reported cyclic changes in cell number corresponding to glandular activity in adult *Diploptera punctata* females (Szibbo et al., 1981). In contrast, by hemocytometric estimations of cell number from dissociated CA cell suspensions and by absolute counts from whole-mount CA monolayers, we have shown that in *Blattella germanica* CA cell number remains constant in adult females throughout juvenile hormone biosynthetic cycles (Chiang et al., 1989, 1991). Here, using the hemocytometric counting technique, we re-examine developmental changes in the CA of *D. punctata*. In mated adult *D. punctata* females, the CA exhibited cyclic volumetric changes in relation to the gonotrophic cycle. In both virgin adult females and males gland volume increased after the imaginal molt but did not cycle as in mated females. In all adult cockroaches, regardless of sex, mated status, or patterns of change in gland volume, total CA cell number initially increased after the imaginal molt and then remained relatively constant. Therefore, although CA cells proliferate in newly emerged *D. punctata* this proliferation is not involved in the regulation of juvenile hormone biosynthetic cycles.

#60

PROGESTERONE RELEASING INTO THE *IN VITRO* MEDIUM AFTER THE LIGATION OF COCKROACH *NAUPHOETA CINEREA* INTESTINES.

Péter Takáč, Milan Kozánek,(Institute of Experimental Phytopathology and Entomology SAS,900 28 Ivanka pri Dunaji,CSFR)

In our presentation had been proved the possibility of Vertebrate-type sex teroid hormones into the *in vitro* medium after the ligation of cockroach *Nauphoeta cinerea* midgut. A sensitive radioimmunoassay for the progesterone determination was used.The cockroaches were selected into four experimental groups. 1.Control group, reared at the standard conditions,2. Group of cockroaches fed by food with progesterone addition, 3.Group of cockroaches fed by food with estradiol addition,4. Group of cockroaches fed by food with testosterone addition. The progesterone concentration after the 6 and 12 hours incubation was measured. In the experimental group of cockroaches after the progesterone addition,significantly different progesterone level from those in the controls was determined,where concentration rised at the level $p< 0.01$. In the group after the estradiol addition into the food,progesterone concentration in the *in vitro* medium was higher in comparison with the control group at the level of significance $p< 0.05$ and 0.01. In the group after the testosterone addition, progesterone concentration was higher at the level of significance $p< 0.05$. Besides we measured the changes of progesterone concentration in the gonads,intestines and haemolymph of cockroach *N.cinerea* after feeding by differnt foods as a food used as starter in turkey rearing (KR 1) and semisynthetic food. Contol animals were fed only by normal water. We did not found the significant difference between animals fed by different foods and only by water.

From our results we may state, that intestine of cockroach *Nauphoeta cinerea* probably has a function during the steroid transport into the haemolymph and then into the target organs.

#61

BIOCHEMICAL GENETICS OF CHYMOTRYPSIN INHIBITOR IN HEMOLYMPH OF *BOMBYX MORI*. Hiroshi Fujii, H. Aratake, L. R. Deng, Y. Kawaguchi, K. Koga, H. Doira, T. Shinohara, and Y. Asou (Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Following gel electrophoresis and biochemical analysis, three distinct groups (low, middle and high molecular weight, 10kDa, 30kDa and 60kDa) of chymotrypsin inhibitors (CI) have been identified in hemolymph of larvae of *Bombyx mori*. The low group included seven electrophoretic variants, the middle group consisted of four and the high group had two. On the results of genetic analysis, CI of low molecular weight was controlled by *Ict-A* which was the complex gene consisting of three genes, on the second chromosome at 23.7, the middle one was under the control of *Ict-E* on the 22nd chromosome at 0.0 and the high one was controlled by *Ict-D* on the 19th chromosome at 9.9. On the biochemical analysis, five CI components of low molecular weight were purified from hemolymph and then their biochemical properties and N-terminal amino acid sequence were determined. They showed stability of both heat and a wide range of pH and a common N-terminal sequence of DKPTT (or DEPTT).

#62

JUVENILE HORMONE(JH) ON THE EUROPEAN HONEYBEES (APIS MELLIFERA L.) AND THE JAPANESE (APIS CERANA JAPONICA RAD.): MECHANISM ON DIVISION OF LABOR AND THE PLASTICITY OF TASK SHIFTS IN HONEYBEE SOCIETY. H. Sasagawa*, Y. Kuwahara, T. Kusano[1] and M. Sasaki[2] Institute of Applied Biochemistry, University of Tsukuba, Tsukuba Ibaraki 305, JAPAN. 1): Institute of Agriculture and Forestry, ibid, 2): Laboratory of Entomology, Factory of Agriculture, Tamagawa University, Machida Tokyo 194, JAPAN. *: Department of Environmental Toxicology, Toxic Substances Research and Teaching Program, University of California-Davis, Davis, CA 95616, U.S.A.

Division of labor (age polyethism) is a characteristic of social bees, controlled by JH-III. Haemolymhal JH, determined by μ-HPLC, of the European (Am) worker increased with age. The JH titer related positively to age and kinds of labor of Am workers, and the Japanese honeybees workers as well.

When Am day-0 workers were treated by methoprene (JHA), guards and foragers appeared much earlier than control. Physiological changes (in vivo and in vitro) were also observed such as α-glucosidase activity for honey production in the hypopharingeal glands, which functioned to produce bee-milk when bees were young. These results indicate that physiological phenomena relating to tasks were governed directly by JH-titer, which increased with age.

Either JHA or 1-oleyl-2-acetyl-glycerol (OAG, protein kinase C activator) was treated to workers to observe behavioral and physiological changes. Age polyethism was accelerated among OAG- and JHA-workers, and their JH-titer corresponded. OAG affected similarly to α-glucosidase activity like JHA. Haemolyphal Ca, essential for activating the kinase C, also increased with age, but no relationship was noticed between Ca and JH titer. These results can explain that age polyethism is affected by individual age and age-composition of colony, and is controlled by JH-titer and Ca level. Plasticity of labor-shift could be mediated by individual JH and Ca titer to activate the kinase C.

#63

P-M CYTOTYPE POLYMORPHISM IN A NATURAL POPULATION OF *DROSOPHILA MELANOGASTER*. Shi-Jie Meng, Ke-xiong Zhang (Department of Biology, Northwestern University, Xian 710069, China)

The P-M system of hybrid dysgenesis in *Drosophila melanogaster* is a syndrome of genetic abnormalities which results from the interaction of two genetic components: P elements and M cytotype. The both components of a natural population of *D melanogaster* from Zhengzhou, a central district in China, were examined by two standard diagnostic crosses (Cross A and A') and studied by genetic analysis of the GD frequencies. The result showed that the population was of M′ strain with some defective P elements. No P elements active for potential GD sterility were revealed in all the tested males, which indicated that the P element activity was monomorphic. But the females tested within both the population sample and the isofemale lines from the population exhibited various abilities (from 0% to 100%) to repress the GD sterility, presenting clearly P-M cytotype polymorphism and strongly bimodal distribution. And it was found that the patterns of the bimodal distribution depended on their mean GD frequency of the tested females from the same line or population. These findings appear particularly important for the knowledge of the population genetics of the P-M system and of its evolution in nature. According to our study here we propose a model of Q element regulation for the cytotype determining and polymorphism forming mechanism in the M′ populations and isofemale lines without any active P elements. The internal relations between the pattern of bimodal distribution and its mean GD sterile prequency are discussed with the model.

#64

A SEQUENCE PRIMED WITH A HUMAN CENTROMERE SPECIFIC MOTIF BY THE PCR METHOD TO GENOMIC DNA OF *BOMBYX MORI* HYBRIDIZES TO FEW CENTROMERIC REGIONS OF HUMAN CHROMOSOMES. Kozo Tsuchida, Kazuhiro Okano, Li Rong Deng, Naoko Miyajima, Hiroyuki Kameoka, Naoko Takada and Hideaki Maekawa (Department of Technology, National Institute of Health, Tokyo 141, Japan.)

The centromere is an important region for maintaining chromosome stability during cell division and the cell cycle. Human centromeric antigens are identified as the CENP group, and one antigen, the CENP-B protein, binds to a specific 17-mer sequence, the so called CENP-B box. This sequence is considered to be conserved among mammalian species. In order to look for this sequence in *Bombyx mori*, which has a diffuse centromere, we carried out fluorescence *in situ* hybridization with a probe amplified by the PCR method. PCR products amplified with the CENP-B box and flanking regions in human genomic DNA hybridised to almost all centromeric regions of human chromosomes and to restricted regions of the *B. mori* chromosomes. Probes amplified by the same primer to *B. mori* genomic DNA hybridized to specific human chromosomes, while they hybridized to all chromosomes of *B. mori*. One type of 1.3kb sequence isolated from the library of PCR products amplified with the *B. mori* genome hybridized to the centromeric region of a specific human chromosome. We will discuss a comparison of this sequence to related centromeric sequences in humans, yeast and other eukaryotes.

#65

SAPID TOOLS: COMPUTER PROGRAMS FOR ANALYSING MULTI-UNIT NERVE RECORDINGS. J.J.B. Smith (Department of Zoology, University of Toronto, Toronto, Ont., M5S 1A1, Canada) and B.K. Mitchell (Department of Entomology, University of Alberta, Edmonton, Alta., T6G 2E3, Canada).

SAPID Tools are a set of programs for digitizing, and separating into component parts, extracellularly-recorded signals from small groups of neurons. They run on standard personal computers under MS-DOS using Intel 80x86 processors and equipped with a commonly available A/D board.
The programs (and source code) are available free from the authors. The programs allow handling of many individual recordings in an efficient manner, but also have a menu-driven interface. They use a pattern-matching algorithm for separating spike-waveforms into different classes, and have many screens designed to allow the user to check and modify the resulting classification. Though designed for use with tip recordings from insect chemosensory sensilla, they can be easily adapted for olfactory and other types of multi-unit recordings. Because they are modular, modification to use other A/D boards, or to add control of stimulus-delivery equipment, is straightforward.

#66

VISUAL RESPONSES OF THE DESERT LOCUST, SCHISTOCERCA GREGARIA, TO REFLECTANCE FROM SURFACES OF DIFFERENT COLOURS

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Single choice tests were conducted to evaluate colour perception in the fourth instar hoppers of crowdedly reared locusts, by using coloured paper strips of different hues and intensities, namely, black, grey, blue series (cobalt blue, turquoise blue, prussian blue), yellow series (cadmium yellow, cadmium yellow pale), green series (light green, medium green, foliage green, green bice), orange and carmine. The reflectance spectra of these colour papers and the spectral irradiance of the light source used in the tests were measured by using Li-Cor Spectroradiometer (Fig. 2). The results indicated that the maximum response was towards cobalt blue. The response to orange, cadmium yellow pale and cadmium yellow ranged from 38 to 48% whereas, the response towards the other colours ranged from 74 to 88%.

When the same coloured paper strips were tested against a brown background, the response declined considerably. The maximum response was towards cobalt blue and carmine. Response towards the other colours ranged from 22 to 48%. These tests indicate that hoppers can differentiate colour contrasts.

#67
THE FUNCTIONS OF AUDITORY NEURONS IN THE CICADA *Cryptotympana atrata*. Jun-Xian SHEN (Institute of Biophysics, Academia Sinica, Beijing 100101, China)

Acoustic communication in cicadas mainly serves to bring the sexes together for successful reproduction. The primary auditory neurons (PAN) respond to proper stimuli with tonic spikes, of similar thresholds of 38-40 dB SPL and encode the intensity and timing by spikes. The auditory interneurons within the thoracic ganglia can be roughly classified into two types, tonic (TAIN) and phasic (PAIN), based on discharge pattern. The discharge durations of the TAINs are of about stimulus duration. Their threshold-frequency relations, intensity and timing coding are similar to those for PANs, but with longer latencies. The TAINs respond to each syllable of the stimuli with different spike count, relative to the syllable sequence. The PAINs discharge few spikes to each stimulus, even if stimulus duration changes from 5 to 100 ms. The PAINs respond only to the onset of the syllable trains and not to subsequent syllables. The females evaluate the distance from the song sources when phonotactically flying toward singing conspecific males. The ipsi- and contralateral threshold differences for auditory neurons are about 15-20 dB. The spike count of TAIN depends on the azimuth of song source. Under the conditions of same stimulus intensity and frequency, mean spike difference at ipsi- and contralateral stimulations is about 4 spikes per stimulus.

#68
COMPARATIVE STUDIES OF STRUCTURES AND PHYSIOLOGICAL RESPONSES OF LARVAL TASTE SENSILLA IN SEVERAL *BOMBYX MORI* STRAINS INCLUDING POLYPHAGOUS ONES. Kiyoshi Asaoka and Jun Inouchi (National Institute of Sericultural and Entomological Science, Tsukuba, Ibaraki 305, Japan)

Two pairs of styloconic sensilla on each maxillary galea and one pair of epipharyngeal sensilla are known as taste organs in lepidopterous larvae. In addition, some bassiconic sensilla on the maxillary palpi are suggested to have taste functions. We investigated structures of these sensilla in several strains of *Bombyx mori* using scanning and transmission electron microscopes. On the other hand, dose of stimuli and spike responses relationships were examined in styloconic sensilla of several strains using tip recording method. We used mostly sucrose, inositol, salicin and strychnine nitrate as stimuli. Some strains are named as polyphagous or non-preference ones which can eat many kinds of plants other than mulberry leaf or low cost artificial diet without mulberry leaf powder. We compared the differences of structures and physiological responses of the sensilla between these strains and normal ones.

Certain differences of sensilla structures were found among the strains, although the relationships with food preference habits did not seem to be present. Differences in physiological responses among the strains were certainly recognized, especially in thresholds or maximum responses of spike frequencies. It is noteworthy that the thresholds to salicin which is one of deterrent substances, were much higher in some polyphagous strains than normal ones. In the other non-preference strains, in which normal and abnormal food habits animals were separated within a same batch, clear differences could not be observed in this experiment.

#69
THORAX STRIDULATING AND ELYTRA VIBRATING SOUNDING AND THEIR ACOUSTICAL PROPERTIES OF BEETLE Anoplophora horsfieldi (Hope)(COL.:CERAMBYCIDAE). Jing-qiu Cheng (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716 , China)

The adult cerambycid beetle, Anoplophora horsfieldi (Hope), has two different ways to produce sound,the thorax stridulation and the elytra vibration. The thorax stridulating sounding (TSS) is produced successively and plays a role both of fighting and communication. The elytra vibrating sounding (EVS), which is produced unsuccessively and induced by external stimulus, has the main role of fighting. The TSS consists of a series of sound groups. A sound group, running about 1100-1600ms, consists of US (up-stroke syllable, 384+22ms, 250--350 PT (pulse train)), Interval 1 (270--600ms), DS (down-stroke syllable, 382+16ms, 250--350 PT) and Interval 2 (80--360ms) ordinally. The power spectrum of US is formed by the BS (basic sound) and its partial. The BS gives the main part of the signal power and has the main peak frequency at 742+30Hz (male) and 603+34Hz (female). The EVS consists of 7 to 9 PT which has both higher amplitude and frequency and runs about 7--10ms. Though the frequencies of EVS are broadly distributed from 0 to 3100Hz, the main power of the signal is aggregated within 850--1050Hz. Comparing with TSS, EVS is more effective in fighting against enemy by its higher energy and sudden release.

#70
A NEUROANATOMICAL AND ELECTROPHYSIOLOGICAL ANALYSIS OF ANTIDROMIC PERISTALTIC BEATS IN THE HEART OF THE SILKWORM BOMBYX MORI. H.Ai and K.Kuwasawa (Department of Biology, Tokyo Metropolitan University, Hachioji; Tokyo, 192-03, Japan)

The dorsal vessel is the heart of the silkworm. The blood flows in the heart from the tail to the head and vice versa after entering the heart through ten pairs of segmentally situated ostia.

In response to tactile stimuli to the body wall at the 8th to 10th abdominal segments, bradycardia or cardiac arrest occured. Tactile stimuli to the antenna, however, caused tachycardia. In the fifth instar larvae within 10 days after the last molt, the heart showed only orthodromic(anterior-going) beats, but in the larvae 11 to 13 days after the molt, the heart showed not only orthodromic but also antidromic (posterior-going) peristaltic beats. Antidromic beats were induced by electrical stimulation of the anterior cardiac branch of an unpaired frontal nerve arising from the frontal ganglion. Extracellular recording showed that the branch was composed of, at least, three axons. The branch back-filled with nickel ions revealed that their somata were located in the frontal ganglion. It is likely that three neurons sending the axons to the anterior cardiac branch are cardio-acceleratory motor neurons for reversed heart beats.

#71
THE ELECTROPHYSIOLOGY AND BEHAVIOUR OF FEEDING AND CHEMORECEPTION IN THE FLESHFLY, SARCOPHAGA BULLATA. U.S. Cheung and J.J.B. Smith (Department of Zoology, University of Toronto, Toronto Ont. M5S 1A1, Canada)

Each sensillum on a fly labellum contains four chemosensory cells and one mechanosensory cell. One of these cells is sugar sensitive, but has at least four receptor sites. These have been called the pyranose (P) site, binding to glucose; the furanose (F) site, binding to fructose; the aromatic amino acid (Ar=Aryl) site, binding e.g. to valine; and the aliphatic carboxylate (R=Alkyl) site, binding to phenylalanine. Experiments are described where the electrophysiological responses to these different stimuli, singly and in combination, are correlated with behavioural responses to diets containing the same substances. The results are presented in the context of understanding the coding of complex (natural) taste signals, the functional significance of multiple receptor sites on a single chemosensory neuron, and the biology of the sense of taste in flies.

#72
BIOACTIVITY RELATIONSHIP OF BASSNS COMPOUNDS WITH GLUTAMATE RECEPTOR CHANNELS OF INSECT. Liu An-Xi, Xu jiang-hua, (Department of Biology, Nankai University, Tianjin)

When applied at 80ppm to a fruit fly (Drosophila melanogaster) larval neuromuscular preparation, N-alkyly-N'-arylsulfonyl-N-substitutent-S-alkyl phosphorodiamidoates (BSSNs) inhibited and eventually blocked excitory junction potentials (ejps) in the abdominal longititude muscle cell. Comparison of compounds structure and time needed to blocked ejp among all 21 BSSNs compounds in test suggested that with number of carbon atoms increasing, the compound blocked ejp faster, confirming that the increase in lipid solubility of compounds resulted in higher bioactivity.

Also BSSNs compounds were found to increase the value of open time (about 2.75 ms, normal 2.1 ms) of single glutamate receptor channel in the extenor tibial muscle cell of locusts. Changing of open time will help the insecticide molecules get into cells through the channel.

#73

A NOVEL KAINATE RECEPTOR IN THE INSECT NERVOUS SYSTEM.

D. Bai, D.B. Sattelle (AFRC Laboratory of Molecular Signalling, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, U.K.), K.A. Wafford (Merck, Sharp & Dohme Research Laboratories, Terlings Park, Eastwick Road, Harlow•CM20 2QR, Essex, U.K)

Studies on the pharmacology of vertebrate brain excitatory amino acid receptors have established the presence of a number of different subtypes. The NMDA, AMPA, kainate and L-AP4 receptor subtypes are ligand-gated ion channels, whereas a metabotropic quisqualate-sensitive receptor activates inositol phosphate metabolism.

In the present study, receptors for L-glutamate were characterized on an identified motor neurone (D_f) in the metathoracic ganglion of the cockroach *Periplaneta americana*. Responses to L-glutamate distinct from all those of receptor subtypes known to date from studies on vertebrate central neurones were observed. L-glutamate activated a chloride channel, resulting in an inhibitory response which was blocked by picrotoxin. Aspartate and ibotenate mimicked this inhibitory response and showed cross-desensitization with L-glutamate. Kainate, its analogue domoate and quisqualate induced on the same neurone dose-dependent, depolarizing responses with slow onset and of long duration. A similar response was also observed on dorsal midline cells in the same ganglion. The response of motor neurone D_f to kainate was insensitive to CNQX and picrotoxin, whereas the response to L-glutamate was picrotoxin-sensitive. Thus, the slow depolarizing L-glutamate response of motor neurone D_f is unlike either the vertebrate AMPA/kainate receptor or the metabotropic quisqualate receptor present on vertebrate neurones, and is also distinct from the fast acting quisqualate receptor present on locust muscle.

#74

ROTARY MOVEMENT OF PUPAL ABDOMEN OF BOMBYX MORI INDUCED BY OUABAIN, AN INHIBITOR OF Na^+-K^+-ATPase. Satoshi Takeda (National Institute of Sericultural and Entomological Science, Tsukuba 305, Japan)

Ouabain, an inhibitor of Na^+-K^+-ATPase, induces non-diapause egg in diapause egg producing pupae of the silkworm, Bombyx mori. It was also observed that ouabain-injected pupae made rotary movement of the abdomen vigorously proir to adult eclosion. The vigorous rotary movement occurred specifically 1 to 2 days before adult eclosion. Ouabain-injection was uniquely effective in the middle stage of pupal-adult development.

The contents of some biogenic amines in brain-suboesophageal ganglion complex of the treated pupa were clearly different from control animals at 1 day before adult eclosion.

#75

NOVEL POLYAMINES IN INSECTS AND SPIDERS. Koei Hamana (College of Medical Care and Technology, Gunma University, Maebashi 371, Japan), Shigeru Matsuzaki (Institute of Endocrinology, Gunma University, Maebashi 371, Japan), Masaru Niitsu, Keijiro Samejima (Faculty of Pharmaceutical Sciences, Josai University, Sakado 350-02, Japan)

Arthropods are unique in that they contain norspermidine and norspermine in addition to common polyamines. Attempts were made to detect and identify unusual polyamines in various organs of insects and spiders by high-performance liquid chromatography and gas chromatography-mass spectrometry. The cockroaches *Periplaneta americana* and *P. fuliginosa* and the crickets *Teleogryllus emma*, *Gryllus bimaculatus* and *Homeogryllus japonicus* contained thermospermine, caldopentamine, caldohexamine, homospermine and aminopropylhomospermidine. This is the first report to show the occurrence of the homospermidine derivatives, pentaamine and hexaamine in insects. None of these novel polyamines were found in the moths *Bombyx mori*, *Antheraea yamamai* and *Galleria mellonella*, the fly *Drosophila melanogaster* and the midge *Orthocladius akamushi*. Aminopropylcadaverine, bis(aminopropyl)cadaverine and aminopentylnorspermidine were detected in the spiders *Nephila clavata* and *Araneus venticosus*. The occurrence of these aminopropyl derivatives of cadaverine has never been reported in animals.

#76

ANTAGONIST EFFECTS OF JH AND ECDYSONE ON POLYAMINE LEVELS IN THE NERVOUS TISSUE OF THE HOUSE CRICKET

C.Strambi, A. Tirard, M. Renucci, P. Charpin, R. Augier and A. Strambi (CNRS, BP 71, 13402, Marseille Cedex 9, France)

Polyamines are known, in Vertebrates, to play a role in behavioral development, axogenesis, synaptogenesis and different biochemical processes. Studies on hormonal regulation of polyamine content in tissues is therefore of great interest. Polyamines, separated by reverse phase HPLC and detected by fluorescence were analyzed in the nervous tissue of 10-day-old adult female *Acheta domesticus*. In the nervous tissue, only spermidine and spermine could be detected. Ovariectomy, performed during the last larval instar resulted in ecdysone deprived adults and significantly increased brain spermidine levels which could be restored to control values by injections of ecdysone.

By contrast, allatectomy which induces JH deprivation, depressed spermidine levels, an effect which could be antagonized by injections of JH.

These results indicate that hormonal environment could greatly affect polyamine metabolism in the nervous tissue of *Acheta domesticus*.

#77

SOUND TRAP FOR RICE PLANTHOPPERS. Zhitao Zhang, Qiang Fu, Guofu Zhao (China National Rice Research Institute, Hangzhou 310006, China), Lunyu Chen, Baitao Yin (Hangzhou Applied Acoustic Research Institute, Hangzhou 311400, China)

Mutual recognition and communication in rice planthoppers, Nilaparvata lugens (Stal), Sogatella furcifera (Horvath) and Laodelphax striatellus (Fallen), depend on substrate vibration. The species-specifical sound signals function as the important sense stimuli, which induce sexual excitation of both sexes and orientation of male to female. Signal production was evidenced by the convolution homomorphic system with four integral parts: the pulse sequence generator, the abdominal vibration unit, the coxatal vibration unit and the mechanical filters. The stridulating organ identified by Zhang (1987) forms the hub of that system. Based on the taxis of male to female signal in the same species, a sound trap apparatus, which comprises the signal generator, the transducer and the mechanical trap, was assembled for laboratory experiment. The results showed that when a cassette player was used as signal generator, on average, 46.7 % of N. lugens males and 48.3 % of S. furcifera males were trapped separately during an experiment period of two hours. The maximum rate of trapping was 66.7 % in N. lugens and 60.0 % in S. furcifera. As males of ricehoppers are apparently attracted by sound signals, or the records thereof, produced by the opposite sex, it becomes possible to trap males by sound.

#78

OUABAIN SENSITIVE Na^+/K^+- ATPase IN THE MIDGUTS OF BLOOD-FEEDING INSECTS. J. A. K. MacVicker, P. F. Billingsley and M.B.A. Djamgoz (Department of Biology, Imperial College of Science, Technology and Medicine, Prince Consort Road, London SW7 2BB, U.K.)

Blood-feeding insects undergo a period of rapid ion regulation and fluid transport during and subsequent to ingestion of a bloodmeal. This diuresis is of considerable significance to their survival, but the physiological mechanisms involved have not previously been identified or characterised. Na /K -ATPase is an enzyme of known ion and water regulatory function and it's activity has been shown to be essential to insect excretory functions.

Ouabain-sensitive Na^+/K^+- ATPase activity has now been demonstrated in the midgut of two economically important dipteran species, the mosquito, Anopheles stephensi and the stable fly, Stomoxys calcitrans. A comparison of the biochemical characterisation of ouabain-sensitive Na^+/K^+-ATPase activity in each species will be made. Despite different methods of digestion th enzyme showed classical characteristics in each species, although a higher persentage of quabain-concitive to-insensitive activity was observed in the stable fly. The immunolocalisation of the enzyme in the midgut of the mosquito and reservoir zone of the stable fly will be demonstrated.

#79

MORPHOGENESIS OF OVARIAN CELL LINE OF PHILOSAMIA CYNTHIA RICINI PUPA INFECTED WITH A NUCLEAR POLYHEDROSIS VIRUS. Qiuwen Pu, Linhong Li, Wenjun Lu (Department of Virolgy and Molecular Biology, Wuhan University, Wuhan 430072, China)

The homologous Philosamia Cynthia Ricini(PCR) NPV was used to infect cell line. Polyhedral inclusion bodies formed in the nuclei of the WVB-Ar-8710 Cell Line, Which was susceptible to the Virus. Over 90% of cells were infected. Product dosages of 2×10^8PIB/ml. The PCR NPV are observed by electron microscopy of Ultrathin sections of infected WVB-Ar-8710 Cell Line. The Ultrastructural change of the infected cells have been observed in the nucleus. an early stage of infection, the infected nucleus hypertrophied gradually, and many nucleoli apperared as the progress of infection. The synthesis and envelopment of the virus nucleocapsid and stages in the formation of the polyhedral inclusion bodies are described. After infection, Virions formed from the Virogenic Stroma of entire nucleus. Network of darkly staining material has formed (Virogenic Stroma) Virogenic Stroma and early stage of the nuclecapsid formation. A large amount of nucleocapsid interspersed for virogenic stroma, which changed into network structure. This network Virus rods are formed. Nucleocapsids acquired in cell nucleus ged envelope. Enveloped virus bundles were occluded by polyhedra. The late stage of PCR NPV replication in cell cultures, Virogenic stroma was dispersed, the polyhedra were matured. This cell line was found to susceptible to PCR nuclear polyhedrosis virus.

STUDIES ON THE MECHANISM OF UPTAKE YOLK PROTEIN BY HOUSEFLY OVARIES. He Gong, Wei Qiu, Wen-hui Zheng (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The uptake of yolk protein and the patency were studied in vivo and in vitro using the EITC and ^{3}H labelled yolk protein. The uptake capacity is dependent on the incubation temperature, time, ovary development stage and external concentration of yolk protein. The greatest uptake that occurred during stage 6 (48 hr, after eclosion) fitted the greatest patency. The patency and the rate of uptake were significantly increased when ovaries were incubated in the presence of JH III. The level of Na^{+}-K^{+} ATPase activity in ovary microsomal fractions rose and fell in concert with the vitellogenic stages of oocyte development. The results showed that the enzyme activity reached the peak in the ovaries of the flies at 48 hr.after eclosion. When JH was injected into or topically applied on the flies, the enzyme activity of microsomal fractions was found higher than the control. When vitellogenic ovaries were incubated in the presence of JH, the enzyme activities increased by 1.3 fold in the homohenates. When JH was added to a microsomal fraction prepared from ovaries 36 hr.and 48 hr. after ecosion, the enzyme activities were increased by 200% and 250%, respectively. We could infer from the results presented here that JH was relative to patency and the enzyme activity, hence regulating the uptake of Vg by oocytes.

THE EFFECTS OF NUTRITION ON THE DEVELOPMENT OF OVARIES AND OVIPOSITION OF ENCARSIA FORMOSA. Wang Qing, Yan yu-hua(Department of Plant Protection,Beijing Agricultural University, Beijing 100094 China)

With the aim of improving the effectiveness of E. formosa for biological control of whitefly in greenhouses at low temperature, importance of the nutrition of E. formosa adults was studied. 1/ Before releasing, the wasp adults without possibilities to parasitize were fed on 10% honey water under 25℃ ± 1℃ with 12h light and 12h dark alternatively for 24, 48, 72, 96, 120, 144, 160 hours respectively. It was determined that the optimum time for the nutrition of treatment of wasps was within 24 hours after emergence. The treated parasitoids, introduced into the cage with plant infected with population of whitefly under 25℃±1℃ with 16h light and under 13℃ ±1℃ with 8h dark alternatively, had the parasitization of 20. 25 blackpupae, while the wasps newly-emerged and reared without any food for 24h at the same conditions,had only the parasitization of 7.68 and 9. 6 blackpupae respectively. 2/The results of dissection of female wasps showed that the length of the ovarioles of the wasps with honey water or without food reached the longest on the 3-rd day after emergence, with the length of 214.56± 12.03 λm, and 199.31+5.59 λm respectively. It indicated that the nutrition of E .formosa had a effect on the development of ovaries and oviposition of the wasp females.

PHOTOPERIODIC AND HORMONAL CONTROL OF PHEROMONE PRODUCTION. Zhi-fu Chen, Qi Ding, Xiang-xiong Zhu, Shao-fu Xu and Jia-wei Du (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025,China)

A neurohormone that regulates sex pheromone production in Heliothis armigera females, originates in the suboesophageal ganglion (SOG). Female moths failed to produce the pheromone after ligation between the head and the thorax or extirpation of SOG. Injection with homogenates of brain-SOG complex or SOG induced a normal level of pheromone production in ligated females. Pheromonotropic activity in brain-SOG rose immediately at the beginning of the scotophase. Then pheromone titer increased within 2 h after the onset of the scotophase. In vitro incubation of brain-SOG under dark or light condition indicated that a significant higher pheromonotropic activity was shown in the medium in which brain-SOG was incubated under darkness. The induction of pheromone production in ligated females by homogenate of brain-SOG was not inhibited by the injection with hemolymph from females at photophase. It seems unlikely that light-activated enzymes, resulting in degradation of neurohormones, are present in the hemolymph during photophase.

STUDIES ON THE ISOENZYMES OF COMMON *PYRALIDAE* INSECT PESTS AND THEIR APPLICATION IN CLASSIFICATION. Jiang Zhongxie (Henan Agricltural Univsrsity, Zhenzhou 450002, China), Meng Xiangfeng (Zhumadian Agricultural Research Institute, Zhumadian 463000, China).

The studies of the estrase isoenzyme of the seven pyralids were conducted with pdyacylamide gel electrophoresis. 1. The isoenzyme bands of the esterase zymograms among the seven pyralids and their sibship's drawings were made which were in accordance with the present classification system. 2. The analysis of the four isoenzymes (EST. MDH. LDH. ADH) of the related species in *Ostrinia* showed that all studied isoenzymes of Asian corn borer were polymorphic and EST. MDH. ADH of European corn borer and Ningxia siberian cocklebur pyralids were polymorphic. By using Nei's formula, it was calculated that the genetic distance between Asian corn borer and European corn borer was 1.219; the one between Asian corn borer and Ningxia siberian cocklebur pyralid in Ningxia was 1.406, and the one between European corn borer and Ningxia siberian cocklebur pyralid was 0.216. Based on the criterion that the genetic distance between subspecies should be close to 0.23, so Ningxia siberian cocklebur pyralid should be regarded as one subspecies of European corn borer *Ostrinia nubilalis* (Hubner).

STUDIES ON THE ACTIONS OF SILKWORM ANTIBACTERIAL PEPTIDES AND IMMUNO-HEMOLYMPH ON SOME CANCINOMA AND INSECT VIRUS Dai Zhuying Zhang Lipin Zhang Xiran Shi Peiyong (Department of Biology, Nanjing Normal University, Nanjing 210024,China)

By the method of ^{125}I-udR incorporation and cell culture the actions of the antibacterial peptides of Bombyx mori, Antheraea pernyi, Phylosamia cynthia ricini and some active components against some kinds of cancinoma and Autographa californica nuclear polyhedrosis virus were studied. The results are as follows: (1) The B_4 transforment cells were obviously inhibited by the immuno-hemolymph of Phylosamia cynthia induced by E.coli.The cells were prevented from adherence to the flask bottom. (2) It was found that the K562 human leucaemia myeloid cells were killed by the antibacterial peptides of Bombyx mori and Antheraea pernyi, the immuno-hemolymph of Antheraea pernyi, antibacterial protein P5 and lysozyme of Phylosamia cynthia. The effect is directly proportional to the concentrations. (3) the antibacterial peptide purified from the hemolymph of Bombyx mori can inhibit the polyherosis formation of Autographa californica nuclear polyhedrosis virus obviously at the concentration of 0.1ug/ml.

CELL CULTURE AND VIRAL INFECTION OF HEMOCYTES OF THE ERI-SILKWORM,PHILOSAMIA CYNTHIA RICINA. Ze-hua Yu, Han-chao Yao,Jian-xin Peng, Qu-hou Chen (Institute of Entomology, Huazhong Normal University, Wuhan 430070, China)

This paper deals with the growth of hemocytes of the eri-silkworm,Philosamia cynthia ricina in cultures. The cells division speed up and formed centres of multiplication when the medium TC-100 was supplemented with appropriate amount of phytoagglutinin (PHA). In primary cultures, it consists of round and spindle-shaped cells, and while in subcultures the cells were mainly in round shape.The experiments conducted clearly demonstrated that the PHA could stimulate the multiplication of insect hemocytes as well as that of mammalian lymphocytes. When the cultured cells were challenged with nuclear polyhedrosis virus of the eri-silkworm (Pcr- NPV) , most cells were heavily infected and the typical cytopathological changes were seen under light microscopy and electron microscopy.

A NUMERICAL TAXONOMIC PRELIMINARY STUDY OF THE GENUS ROMANOMERMIS (NEMATODA : MERMITHIDAE) IN CHINA. Xue-chun Bao, Qi-gui Luo (Department of Biology, Central China Normal University, Wuhan 430070, China), Yang Zhong (Wuhan Institute of Botany, Academia Sinica, Wuhan 430074, China)

This paper deals with the diagnosis of species of Romanomermis genus in China using the numerical taxonomic methods.

A Q clustering analysis for 12 OTUs of Romanomermis genus in China, including 6 species of this genus and 7 populations of R. wuchangensis, based on 43 characters has been undertaken by means of the average Euclidean distance coefficients and UPGMA method. The phenogram indicated that 12 OTUs were classified into 3 groups corresponding to 3 taxonomic species respectively, i. e. R. jingdensis (Syn. R. jianensis) and R. sichuanensis as well as R. wuchangensis (Syn. R. yunanensis, R. chenshouensis). And the combined line l_2 (1. 4681) was considered as a line for diagnosis of the species.

Furthermore, the morphometric data of each OTU and the differences of sensitivity to host as well as the biological characteristics of the mating test were discussed. We think the results of Q clustering analysis comparatively tally with the actual situation.

ANALYSIS OF MULTIGENE FAMILY EXPRESSION: SERINE PROTEASE GENES FROM ECTOPARASITIC FLIES (SHEEP BLOWFLY AND BUFFALO FLY). Christopher M. Elvin, Peter W. Riddles, Vicki Whan , Tony Vuocolo (CSIRO, Division of Tropical Animal Production, Long Pocket Laboratories, Indooroopilly, Queensland 4068, Australia)

The development of methods for the control of ectoparasites is complicated by a lack of knowledge regarding interaction of the parasite with its bost. Since serine proteases are known to be involved in digestion of the blood meal and avoidance of the bost's immune system, in addition to playing important roles in many vital physiological processes, we reasoned that this family of proteases may represent promising vaccine candidates. The extracellular nature and bence their accessability to bost antibody, is also an important consideration in assessing the potential of these enzymes as vaccines.

Little is known about the proteases of adult buffalo fly or sbeep blowfly larvae and methods were sought that would give a rapid assessment of both the diversity and extent of serine protease expression. A generic PCR-based method was investigated whicb could be applied to any multigene family in whicb individual members shared at least two regions of conserved primary sequence (Sakanari *et al.* (1989)). This method is based on PCR amplification of total fly (first instar sbeep blowfly larvae or adult buffalo fly) cDNA using generic serine protease-specific primers based on the conserved amino acids surrounding active site His-57 and Ser-195 residues.

The amplified DNA product (of approximate size 480 base-pairs) was cloned into a plasmid vector and a number of individual clones were digested with the frequently cutting restriction enzymes HaeIII or IIinf I. Groups of cloues were identified on the basis of th restriction fragment patterns obtained following gel electrophoresis. In adult buffalo fly 13 of 18 independent clones sbowed individual-specific restriction fragment patterns. Iu sbeep blowfly larvae, 70 independent cloues were investigated and 49 different classes were assigned. A representative from 10 of these different groups was sequenced and compared with the known sequences of proteases lodged on GENBANK and NBRF databases. The distribution of proteases in the cDNA is likely to approximate the abundance of mRNA for a particular type of protease. We were able to identify , by couparison, broad groups of enzymes similar to collagenases and trypsin as well as some enzymes without identifiable properties. Keeping in mind the complexity of the serine protease gene family, this approacb will have general application to the analysis of transcription from other multigene families.

ESTABLISHMENT OF A CELL LINE FROM PUPAL OVARY OF PHILOSAMIA CYNTHIA RICINI. Qiuwen Pu, Min Hu, Wenjun Lu (Department of Virology and Molecular Biology, Wuhan University, Wuhan 430072, China)

A cell line was established from pupal ovary of philosamia Cynthia ricini and designatet as WVB-Ar-8710. The primary culture was initiated in october 1987. The cell line WVB-Ar-8710 was established from pupal ovarian tissues of Philosamia Cynthia ricini. The cell line has been transfered for 102 passages in 36 months. The medium BML-TC100 supplemented with 20% Fetal Calf serum was suitable for culturing pupal ovaries of Philosamia Cynthia ricini and TC Tryptose broth has the ability to stimulate the growth of the silkworm cells. Suspension containing cell masses and singlecells was subcultured with the split ratio of 1: 2. The WVB-Ar-8710 mainly consists of three cell types epithelial-like, spindle-shaped and round cells. The cells population doubling time was 60-64 hr and the maximum cell population per milliliter was 4. 3 times as the initiated cell density. Karyotypes of cell line WVB-Ar-8710 from pupal ovary of Philosamia Cynthia ricini was analysed. The size of them are rather small, short and the number varies greatly from less than 90 to more than 130. The type of chromosomes reveals that it belongs to the karyotype of lepidoptera.

THE INDUCTION OF TRICHOGRAMMA DENDROLIMI AND ENERGE METABOLISM OF DIAPAUSING STAGE. De-jun Cui (Jilin Academy of Agricultural Sciences, Jilin Province 136100, China)

The prepupal diapause can be initiated in the artificial inductive condition. The larva and prepupa can receive the external stimuli to enter diapause on prepupa stage. During diapausing stage of T. dendrolimi, the respiratory rate is approximately 50% less than that in non-diapausing prepuapa at 25℃. But the dissociative ATP is twice as many as that in non-diapausing prepupa at 25℃.

IDENTIFICATION OF A NUMBER OF NOVEL MYOTROPIC PEPTIDES FROM 3 INSECT SPECIES. De Loof A., Schoofs L., Paemen L., Tips A., Fonagy A. and Spittaels K. University of Leuven, Belgium

The isolated hindgut of *Leucophaea maderae* and the oviduct of *Locusta migratoria* are rapid and reliable bioassays for the detection of myotropic and myoinhibiting peptides in biological samples. HPLC-purification combined with these detection-assays allowed us to purify numerous peptides from several insect tissues. Seventeen myotropic and three myoinhibiting peptides were identified in the central nervous system (CNS) of the locust. In addition to 9 structurally unique peptides or peptide families, other peptides (locustasulfakinin and locustatachykinins) show structural and biological features similar to the sulfated vertebrate peptides cholecystokinin/gastrin and to the tachykinins physalaemin and substance P. Antisera were developed against the locustatachykinins, the locustamyotropins, locustamyosuppressin, locustamyoinhibiting peptide and Lom-AG-MT I and II. Immunocytochemical methods were applied to study the distribution of these neuropeptides in the CNS and to reveal their possible target organs. Double stainings reveal which neuropeptides are produced by the same cells and which by different sets of neurones. The influence of the locust neuropeptides on cAMP-levels and on the membrane potential of their target organs was investigated in a series of physiological studies. From the Malpighian tubules, four oviduct stimulating peptides were identified, three of them having a unique structure, whereas the fourth peptide was LomAG-MT I. Lom-AG-MT I and II are neuropeptides, that were isolated from accessory glands and immunologically identified in distinct neurons in the CNS with axon terminals in the muscle layer surrounding the gland tubules. The identification of identical peptides in different target organs together with immunocytochemical studies indicate that many of the recently identified peptides are important neurotransmitters, involved in the regulation of several biological processes. In *Sarcophaga (Neobellieria) bullata* heads, we identified two sulfakinins and one myosuppressin and in *Leptinotarsa decemlineata*, six peptides with a unique structure were sequenced.

IDENTIFICATION OF HOUSEFLY BURSICON WITH MONOCLONAL ANTIBODIES. Michael Ma and Qisheng Song (Department of Entomology, University of Maryland, College Park, MD 20742, U.S.A.)

We have developed a protocol for generating monoclonal antibodies to neurosecretory cells of the adult housefly, *Musca domestica*. One cell line, 01C10, was found to immunostain the posterior lateral neurosecretory cells of the protocerebrum, and the corpora cardiaca. After one hour of adult eclosion, the immunostaining in the corpora cardiaca was gone indicating the release of immunostained material into the hemolymph. Western blot analysis showed that the monoclonal antibody was specific to a 56 KD polypeptide found in the brain, CC, and the hemolymph. A combination of HPLC and immunoaffinity chromatograph was used to reveal the functional nature of the 56 KD polypeptide. The results showed that the immunostained polypeptide was bursicon.

ADIPOKINETIC HORMONES IN THE LOCUST: THEIR STRUCTURE AND ACTION. Wil J.A. Van Marrewijk, Rob C.H.M. Oudejans and Dick J. Van der Horst (Department of Experimental Zoology, University of Utrecht, Padualaan 8, 3584 CH Utrecht, The Netherlands)

Mobilization of carbohydrate and lipid stores from fat body as fuels for locust flight is controlled by adipokinetic hormones (AKHs). Two structurally related AKHs are known to be involved, the decapeptide AKH I and the octapeptide AKH II. Recently we have identified a third adipokinetic hormone (AKH III) in *Locusta migratoria* whose sequence, based on FAB-MS, is < Glu-Leu-Asn-Phe-Thr-Pro-Trp-Trp-NH_2. We use the AKH-fat body system as a model for studying possible differences in signalling and signal transduction of these structurally related peptides, which may contribute to our understanding of the physiological significance of the occurrence of structurally related neuropeptides within one animal species. All three AKHs show both lipid and carbohydrate mobilizing effects. AKH I is the most potent with respect to lipid mobilization, while AKH II is the most potent in carbohydrate mobilization (glycogen phosphorylase activation). For both parameters AKH III is less potent; at high doses, only in lipid mobilization the same maximal response can be reached as found with AKH I. Both AKH I and II require extracellular Ca^{2+} for their activating effect on phosphorylase. In the absence of AKH, Ca^{2+} ions have no effect. Elevation of intracellular cAMP levels with forskolin or theophylline causes phosphorylase activation. This cAMP effect is independent of extracellular Ca^{2+}. The formation of [^{3}H]inositol phosphates from phosphoinositides prelabelled with *myo*-[^{3}H]inositol indicates the functioning of the inositol lipid cycle in locust fat body. Phosphoinositide turnover is stimulated by AKH I and II, suggesting a central role of this system in the signal transduction mechanism of these hormones.

HORMONAL CONTROL OF PIGMENTATION BY NEUROPEPTIDES. Detlef Bückmann, Abteilung Allgemeine Zoologie, Universität Ulm, Albert-Einstein-Allee 11, D-7900 Ulm, Germany

In insects many forms of ontogenetic and morphological color change, color adaptation, and pigmental diphenism are controlled by different hormonal mechanisms, which have been evolved only late in the evolution, independently in adaptation to the special ecolocical conditions and live history of single species. Pigmentation is controlled by juvenile hormone in some Orthoptera and by ecdysteroids and juvenile hormones in some Lepidopteran larvae, the production of these hormones being under superior control by neuropeptides. However, neuropeptides can also act directly on pigmentation. This applies mainly to neuropeptides of the trunc nervous chain. In some adult Lepidoptera seasonal diphenism is controlled by the timing of ecdysone release and thus dependent on pupal diapause. In other cases it is controlled directly by a neuropeptide.

In the Rhopaloceran pupae, which are not sheltered by cocoons, color adaptation is controlled by a neuropeptide of the trunc nervous chain which reduces melanization and enhances carotenoid incorporation into the pupal cuticle. Its release is controlled by the anterior ganglia, but the peptide itself is found in the abdominal ganglia, too. It has a molecular size of about 3000 D and could be found as well in species without color adaptation and even in Decapod Crustaceans.

ADENOTROPIC NEUROHORMONES IN *DROSOPHILA*. D.Zitnan, F.Sehnal, P.J.Bryant (Developmental Biology Center, University of California, Irvine, CA 92717l, U.S.A.)

Antibodies to *Bombyx mori* PTTH and bombyxin and *Manduca sexta* allatotropin react in *Drosophila* with specific sets of neurons, some of which appear homologous to the recognized sources of the examined neurohormones in Lepidoptera. Double staining revealed that antigens detected with employed antibodies in *Drosophila* are never co-localized. PTTH immunoreactivity occurs in feeding larvae in 2 pairs of lateral neurons in the brain and 15 pairs of lateral neurons in the ventral ganglion. It is high in the wandering larvae, lacking in newly ecdysed pupae but reappearing during adult development, and peaking in the reproducing adults. Weak reactivity to bombyxin antibody is confined to 3 pairs of medial brain cells in postfeeding larvae plus 2 pairs of ventral cord neurons in pharate adults, while in the reproducing adults it includes in the brain 1 pair of medial, 3 pairs of lateral, and 3 pairs of optic lobes neurons. Staining with allatotropin antiserum is high in fully grown larvae, undetectable in freshly ecdysed pupae, and maximal in reproducing adults. In larvae it occurs in 7 pairs of medial and 3 pairs of lateral brain neurons and in 6 pairs of ventral cord neurons; additional clusters of 10 brain neurons and 5 pairs ventral cord neurons are stained in the adults. Larvae carrying imaginal disc overgrowth mutations *dlg* or *dco* exhibit strong immunoreactivity for allatotropin, indicating that the pupariation inhibition in these larvae could be caused by enhanced JH production in response to superfluous allatotropin secretion.

A NEW DIURETIC HORMONE FROM THE TOBACCO HORNWORM, *MANDUCA SEXTA*. Michael Ma and Michael Blackburn (Department of Entomology, University of Maryland, College Park, Maryland 20742, U.S.A.)

A 30-amino acid diuretic peptide was isolated from the corpora cardiaca-corpora allata complexes and, separately, from median neurosecretory cells of the Sphingid moth, *Manduca sexta*. The peptide was found to have the folowing sequence, determined by automated Edman degradation and mass spectrometry: SFSVNPAVDILQHRYMEKVAQNNRNFLNRV-NH_2. We have named the peptide Mas-DP II. The peptide was synthesized and shown to possess the diuretic activity in decapitated moths. Mas-DP II is related by sequence homology to a 41 amino acid diuretic peptide identified previously from *M. sexta*, and it belongs to the family of corticotropin releasing-like peptides.

QUANTIFICATION OF ALLATOSTATIN IN TISSUES OF DIPLOPTERA PUNCTATA IN VIVO: DEVELOPMENT OF A HIGH SPECIFICITY AND SENSITIVITY ELISA BASED ON PURIFIED ANTIBODY AND A MINI-C_{18} RP SOLID-PHASE EXTRACTION CHROMATOGRAPHY.

C. G. Yu (Department of Zoology, University of Toronto, Toronto, Canada), B. stay, S. Joshi (Department of Zoology, University of Iowa, Iowa city, Iowa, USA). S. S. Tobe (Department of Zoology, University of Toronto, Toronto, Canada).

Rabbit antibody specific to allatostatin 1 (AST 1) from *Diploptera punctata* has been prepared and characterized. The antibody was purified with ammonium sulfate precipitation, protein A column chromatography, followed by affinity chromatography on a KLH-Sepharose column, and an AST 1-Sepharose column. The purified antibody showed only slight cross-reactivity with AST 2, AST 3, AST 4 and AST 5. Mini-C_{18} RP-solid-phase columns were used to isolate AST-like peptides from individual brains of *D. punctata*. We have subsequently developed a sensitive ELISA to quantify the AST-like peptides from individual brains and hemolymph of last instar and mated females of *D. punctata* during the first gonadotrophic cycle. AST content increased during the first 3 days of adult life, then dropped on day 4, and increased again to a maximum on day 5. During the early stages of the first gonadotrophic cycle, the concentration of AST in hemolymph was very low (0.1-0.2 pmole per ul). It reached 3.2 pmole/ ul on day 13 then dropped gradually. By day 50, it had decreased to 0.5 pmole/ul. During the early last stadium, the concentration of ASTs in the hemolymph was also very low. However, it began to increase on day 7, reaching a maximum of 1.6 pmole per ul on day 13 and then dropped slightly thereafter for the remainder of the stadium (1.0 pmole per ul). ASTs were released from complexes of corpora allata-corpora cardiac (CC/CA) of *D. punctata* during incubation. The rate of release was high between 1.5 and 4 hr after the start of incubation and decreased thereafter. Treatment with high potassium elicited a drastic increase in AST release from CA/CC into the medium.

ESTIMATING GENE FLOW AMONG INSECT POPULATIONS IN MANAGED AND NATURAL SYSTEMS. George K. Roderick (Department of Entomology, University of Maryland, College Park, Maryland 20742, USA)

Gene flow is a central process in population biology and can be used to predict many important parameters in population biology, including 1) migration of insects pests and natural enemies, 2) the movement of genes conferring resistance to insecticides or to novel host plants, and 3) the spread of insect-vectored plant diseases. With the advent of new molecular techniques, methods for estimating gene flow can shed new light on insect movements; yet, these methods have become more complex. Here, I review available techniques for estimating gene flow among populations of insects in both managed and natural systems. Because some estimates are based on mitochondrial markers and some on nuclear markers, gene flow of males and females can now be studied separately. Finally, to illustrate these techniques, I present examples from managed and natural populations of Colorado potato beetles (*Leptinotarsa decemlineata*) (Coleoptera: Chrysomelidae) and rice stem borers (Lepidoptera: Pyralidae).

DNA PROBES IN INSECT SYSTEMATICS AND THE ANALYSIS OF INSECT POPULATION STRUCTURE. J.M. Crampton, S. Hill, R. Urwin, A. Githeko (Wolfson Unit of Molecular Genetics, Liverpool School of Tropical Medicine, Liverpool, UK.)

Systematics encompasses both taxonomy and phylogenetic reconstruction and both rely on the use of characteristics which have a strong genetic base. Techniques involving the analysis of DNA sequences should therefore represent the most direct approach to insect systematics. In this respect, a number of methodologies incorporating molecular techniques have been assessed in terms of their applicability to problems of insect taxonomy and identification. We have concentrated our efforts on the development of DNA probe systems which allow the identification of specific insect species and populations. The strategies which may be utilised to develop species-specific DNA probes will be discussed with the main emphasis of the presentation being placed on the refinement of a simple methodology suitable for the identification of insect specimens and population studies in the field. A number of examples will be used to illustrate the approach with particular emphasis being placed on probes for the identification of insect vectors of disease. Clearly, other methods for the identification of insect specimens are available, including morphometrics, isoenzyme analysis, cytogenetic techniques and mating incompatibility. However, many of these techniques are limited to a specific life stage of the insect. DNA probes do not suffer from this limitation and data will be presented where the use of DNA probe technology has extended our understanding of insect vector population structure and dynamics. Finally, the likely developments in DNA probe technology will be considered in relation to its future use in the study of insect systematics.

GENETICS OF *AEDES (STEGOMYIA) ALBOPICTUS*, THE ASIAN TIGER MOSQUITO. Leonard E. Munstermann, William A. Hawley and John-Paul Mutebi (Vector Biology Laboratory, University of Notre Dame, Notre Dame, IN 46556, U.S.A.).

Although it is an established vector of dengue-hemorrhagic disease in Asia, *Aedes albopictus* has been subjected to relatively few genetic studies. In 1981, Tadano (St. Marianna's University, Japan) began a more extensive formal genetic characterization; by 1990, he had recognized 3 linkage groups (corresponding to the 3 pairs of chromosomes) by positioning 7 morphological markers and 5 enzyme loci. Recently in our laboratory, 2 additional mutants were discovered and linked to sex (bronze-body and red-eye). By interspecific hybridizations with *Aedes flavopictus*, 3 enzyme loci were added (Idh-1 to group I, Mdh-2 to group II, Hk-4 to group III). Extension of the linkage map with additional enzyme loci have permitted comparisons with the maps of *Aedes aegyti* and *Ae. triseriatus* and extending inferences concerning chromosomal evolution in aedine mosquitos. ... Polymorphisms at 27 enzyme loci were used to track genetic relatedness of *Aedes albopictus* populations in a north-south transect across Asia. Adults were sampled by landing-biting collection from 58 sites in Indonesia, Singapore, Malaysia, Thailand, The Philippines, Taiwan and Japan. The mosquitoes were immediately frozen in liquid nitrogen and later tested for enzyme profile. Frequencies and distributions of alleles permitted inferences about colonization events and local population structure. Distribution of variants in a-glycerophosphate dehydrogenase (Gpd), isocitrate dehydrogenases (Idh-1, Idh-2) and mannosephosphate isomerase (Mpi) isozymes provided the clearest clues to its probable geographic origins in Indonesia. Isozyme profiles permitted the identification of the morphologically similar *Aedes pseudalbopictus* in the samples and consequently, an substantial extension of its previously recognized range.

CHARACTERISATION AND EVOLUTIONARY HISTORY OF A RETROTRANSPOSON FROM *AEDES* AND *CULEX* MOSQUITOES. C. Mouchès, N. Bensaadi, J.C. Salvado, S. Rouet-Karama, P. Blanchard (Laboratoire d'Ecologie Moléculaire, Université de Pau et des Pays de l'Adour. 64000 Pau, France)

Mobile elements have become important tools for gene transfer, insertional mutagenesis and gene cloning using transposon tagging. Moreover, some transposable elements are the agents that cause in *Drosophila* a syndrome of genetic traits known as 'hybrid dysgenesis'. We have developped different strategies in order to isolate such transposable elements from mosquitoe species.

Among the various transposon-like elements we have isolated in this way, the Juan elements belong to a family of reiterated sequences scattered through the genomes of *Aedes* and *Culex* mosquitoes. The overall genetic organization of Juan elements is similar to that of long interspersed repetitive elements (LINEs), the class of nonviral retrotransposons. Full-lenght copies of Juan elements from *Aedes aegypti* are 4.7 kilobases (kb) long. They are terminated at the 3' end by an adenosine-rich sequence and are flanked by target-site duplications. They displays two long open reading frames (ORFs) potentially encoding two proteins. One of these proteins features cystein-rich motifs typical of retroviral gag polyproteins while the other shows homology to the reverse transcriptase. These data indicate that Juan elements could transpose by reserve transcription of an RNA intermediate. The structure and the nucleotide sequence of the Juan homologues in *Culex* resemble that of the Juan element of *Aedes*.

Sequences of complete Juan elements of several non sibling *Aedes* species are very similar, suggesting that these elements have spread recently in these species. Such a recent invasion of the *Aedes* genomes by active Juan elements could have originated by horizontal transfer from another species.

INTRASPECIFIC VARIATION IN THE DNA SEQUENCES OF rDNA SPACERS IN BLACK FLIES. Charles L. Brockhouse[1,2], Neil A. Straus[2], and Robert M. Tanguay[1]. ([1]Insect Biotech Canada and Laboratoire de Génétique Cellulaire et Moléculaire, Centre de Recherches du CHUL, Ste-Foy, Qc., G1V 4G2 CANADA and [2]Botany, University of Toronto, Toronto, Ont., M5S 3B2 CANADA).

In the face of the development of insecticide resistance in economically important insects, the ability to monitor con-specific populations for migration and population stability has become increasingly important. This is especially true in black flies, which are refractory to laboratory breeding and therefore to genetic analysis of the insecticide resistance traits. In our studies of sibling species in black flies we have found that the Internal Transcribed Spacer (ITS) regions of the rDNA loci evolve sufficiently rapidly to distinguish con-specific populations. ITS sequences were isolated by PCR from three samples of *Prosimulium multidentatum*, representing two populations. The first was collected from Rockford (near Owen Sound, Ont., Canada) in 1970. This was followed by a second collection in 1990, a span of time equalling 20 generations. A third sample was obtained from a site 120 km distant from Rockford in 1989 (Terra Cotta, Ont.). Multiple insertion/deletions, base pair substitutions and changes in the amount and locations of base-pair polymorphisms were observed. The rate of sequence change at the Rockford site was equal to 0.14% per year (or generation). The high rate of change at this site implies population instability in the years between samplings. Greater divergence was observed between the two sites. These data suggest that ITS sequences are suitable for monitoring con-specific populations both for migration and stability.

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Genetic variation in the migratory grasshopper - a multi-level approach. W. Chapco, Dept. of Biology, University of Regina, Regina, Saskatchewan, Canada S4S 0A2. The migratory grasshopper Melanoplus sanguinipes (F.) is one of a few insect pests on the prairies causing millions of dollars of annual damage. Central to the success of any control program is genetic knowledge both of the population structure and amount of variation within a given species. As with most Orthopteran organisms, such information is only recently being acquired. Saskatchewan populations are characterized by a marked genetic cline with respect to a hind tibia color trait, contrasting with the rather uniform distributions of isozymic and mitochondrial DNA variants. Widespread gene flow is suggested; forces underlying the cline must therefore be sufficiently powerful to withstand the attenuating effects of movement. Low amounts of isozymic and mitochondrial DNA variation are in keeping with the view that M. sanguinipes is a recent "colonist" to the area. Recently obtained data based on the polymerase chain reaction using short primers of arbitrary sequence and primers flanking regions of rRNA genes are being analyzed to provide independent assessments of variation and differentiation in this insect.

GENETIC VARIATION IN THE MEDFLY, CERATITIS CAPITATA, DETECTED BY DNA FINGERPRINTING AND PCR AMPLIFICATION OF RANDOM SEQUENCES. David S. Haymer (Dept. of Genetics and Molecular Biology, Univ. of Hawaii, Honolulu,HI 96822) and Donald McInnis (ARS,USDA, P.O. Box 2280, Honolulu, Hawaii)

We have used DNA fingerprinting and PCR amplification of random sequences to assess genetic variation between individuals and populations of the Mediterranean fruit fly, Ceratitis capitata. The DNA fingerprinting analysis involves probing Southern blots of genomic DNA extracted either from single flies or from large scale procedures. Using either M13 or repetitive sequences cloned from the Medfly genome, reproducible restriction fragment length polymorphisms can be detected between strains originating from different gegraphic localities, including different islands within the Hawaiian archipelago.

We have also shown that RAPD (randomly amplified polymorphic DNAs) markers, amplified using PCR, can be used as strain specific molecular markers. Using this approach we have identified several primers which produce patterns of amplified sequences which are specific to strains and individuals originating from different geographic localities. We have examined material from different Hawaiian islands, Guatemala, Israel and even captured material from a recent infestation in California. From this material we hope to be able to determine the genetic origin of flies invading a new habitat.

MOLECULAR BIOLOGY OF THE SPRUCE BUDWORM, CHORISTONEURA FUMIFERANA. Felix Sperling, Shaojiu Wang, and Donal Hickey (Department of Biology, University of Ottawa, Ottawa, CANADA)

We have initiated a research programme to characterize the gene and genome structure of the spruce budworm; the long-term goal of this work is to apply genetic engineering techniques to the control of this important pest insect. We have prepared cDNA and genomic lambda libraries from Choristoneura larvae and have screened these libraries for specific gene sequences. We are currently characterizing sequences that code for two important digestive enzymes, namely, alpha-amylases and trypsin-like enzymes. Preliminary results indicate that Choristoneura gene sequences are closely related to those of other Lepidopteran species. The isolated genes are being used as molecular markers to investigate biosystematic and biogeographic relationships within the C. fumiferana species complex. PCR-amplified mitochondrial sequences are also being used for this purpose. In addition to the studies of population structure, we are also interested in the control of gene expression in Choristoneura.

OVERVIEW AND CURRENT STATUS OF INSECT GENETICS. Narang Sudhir Karl (Biosciences Research Laboratory, USDA, ARS, P.O.Box:5674, Fargo, ND 58105,USA)

Many economically important insects are species complexes comprised of morphologically indistinguishable sibling species. Generally, genetic variability among populations reveals geographical, temporal, clinal and other ecologically related patterns. In many cases, total population of a species is subdivided into one or more types of population structures (panmictic, isolation-by-distance and discrete subpopulation), each with its characteristic genetic makeup. Successful applications of genetic and biological control programs require that the species and its population structure(s) be reliably identified. Electrophoretic, DNA RFLP and PCR-based methods are described to determine the nature, pattern and extent of genetic variability. Step-by-step procedures for identification of three most common types of population structures are discussed. Some examples of population structures and data on genetic differentiation are presented for illustration.

FACTORS AFFECTING INTRASPECIES COMPETITION IN TRIBOLIUM CASTANEUM(HERBST)(COLEOPTERA:TENEBRIONIDAE). Alexander Sokoloff. (Biology Department, California State University, San Bernardino, California, 92407 USA): M. A. Hoy (Entomology Department, University of California, Berkeley, California, 94720 USA).

Although there have been many studies in interspecies competition, studies of intraspecies competition have not been performed because of a lack of suitable markers. In this investigation we have studied intraspecies competition using strains selected for high body weight and strains not selected for size (but marked with body color genes) singly and in combination. Data will be presented to show that genotype, sex and size are important in the outcome of intraspecies competition as reflected by the number of survivors, weight and biomass.

THE ASSOCIATION BETWEEN CHROMOSOMAL VARIATION AND LIFE HISTORY TRAITS ALONG A LATITUDINAL CLINE IN A SUBSPECIES OF THE AUSTRALIAN GRASSHOPPER *Caledia captiva*. Dave Shaw & Fran Groeters (Molecular Evolution & Systematics, Australian National University,. Canberra, A.C.T. 2601. Australia).

The chromosomes of a subspecies of *Caledia captiva* show systemic patterns of change along a latitudinal cline in S.E. Australia. All chromosomes within the genome (2n=24) change gradually from metacentric in the north to acro/telocentric at the southern limit of the cline - a distance of 1500km. These chromosomal changes are associated with gradual changes in life history patterns that include voltinism, rates of embryonic development and diapause induction.

It will be argued that these changes in developmental and life history traits are direct phenotypic expressions of the changes to genome structure that have permitted this tropical insect to invade the cool temperate regions of S.E. Australia.

We will attempt to show that the changes to the biophysical organisation of the genome can alter cellular parameters that regulate important phenotypic characters which, in turn, adapt this organism to its immediate environment.

A tumor-suppressor gene encoding a junctional protein in *Drosophila*. Daniel F. Woods and Peter J. Bryant, Developmental Biology Center, University of California, Irvine, Irvine, California 92717, USA. We are investigating the genetic control of cell proliferation in *Drosophila* imaginal discs, by cloning and characterizing genes in which mutations lead to imaginal disc overgrowth (tumor-suppressor genes). Mutations of the *lethal(1)discs large-1* (*dlg*) gene cause neoplastic overgrowth of imaginal and embryonic epithelia. The mutant cells show loss of apical/basal cell polarity, and imaginal cells fail to differentiate. We have cloned the gene and sequenced a near-full length cDNA corresponding to one of the major transcripts present throughout development. A sequence of 179 amino acids near the C-terminus of the predicted *dlg*-A protein shows homology to yeast guanylate kinase, an enzyme that catalyzes the reaction 5'GMP+ATP ⇌ GDP+ADP. Three *dlg* alleles have DNA alterations in or near this guanylate kinase domain. The predicted *dlg*-A protein also contains a motif homologous to SH3, a putative regulatory domain in non-receptor protein tyrosine kinases and other signal transduction proteins. The N-terminal half of the molecule shows limited homology to several filamentous proteins. Confocal immunofluorescence analysis using antibodies directed against fusion peptides of *dlg*-A show that the gene product is localized in an apical belt of the lateral cell membrane in epithelial cells, at the position of the septate junction. These junctions are reduced or missing in epithelial tissue lacking the *dlg* protein. Several different proteins, including the cell adhesion molecule fasciclin III, are enriched at this part of the lateral cell membrane. Other proteins, including neuroglian, are present on the lateral cell membrane but are specifically excluded from the septate junction zone. These patterns of localization depend on the presence of the *dlg*-A protein, suggesting that this protein is important in establishing the zonation of the lateral cell membrane and in organizing septate junctions. Our results also suggest that a signal transduction process involving guanine nucleotides occurs at septate junctions and is necessary for proliferation control in epithelial cells.

ENZYME DATA AS A TOOL FOR RECONSTRUCTION OF DISTRIBUTIONAL PROCESSES. Mossakowski, Dietrich (Evolutionary Biology, University of Bremen, P.O.Box 330440, D-2800 Bremen, Germany).

In Europe, there exist large regions which were formerly covered by the ice shields of the quarternary glaciations. Nowadays, living in these regions, many species must have been immigrated from their refugia. Under the likely assumption that the migrants took along only a part of the genetic variability of the refugial population, and using electrophoretic morphs of enzymes as markers, it should be possible to reconstruct the number and the localities of the refugia.

The species of *Chrysocarabus*, a subgenus of *Carabus* (Col., Carabidae), have relatively small areas of distribution, e. g. *C. splendens* occurs in the Pyrenees and in some isolated populations in the Cevennes (Northern Spain and South-West of France). In *C. splendens*, it is likely that there were two refugia during the period of glaciation; one in the Basque region and another in the Cevennes. The enzyme data do not fit to any other hypothesis. In *C. lineatus*, living from the Cantabrian Mountains up to the western Pyrenees, the number of refugia is much higher.

The species mentioned above show a cold-period refugium. The data of *C. lateralis*, living in Galicia and the northern parts of Portugal, suggest an other interpretation. During the last interglacial period the mean temperature was about two degrees higher and the vegetation of Lauro-Silvaea more widespread than today. In the remainders of this formation this species does not occur. This pattern is called a warm-time refugium.

Beside these intraspecific interpretations, a reconstruction of the historical changes based on the phylogenetic relationships is presented.

POLYACRYLAMIDE GEL ELECTROPHORESIS OF ENZYMES OF NEPHOTETTIX VIRESCENS (HOMOPTERA: CICADELLIDAE) POPULATIONS FROM INDIA, SRI LANKA AND THE PHILIPPINES. G.F. Rajendram, Department of Zoology, University of Jaffna, Sri Lanka.

Polyacrylamide gel electrophoresis was carried out on Nephotettix virescens (Distant) adults collected from India, Sri Lanka and the Philippines and maintained in glass-houses on rice variety TN-1 at the University of Wales, Cardiff, United Kingdom. The following enzymes showed activity and were recorded: acid phosphatase (ACP), α-glycerophosphate dehydrogenase (αGPD), fumarase (FUM), glucose-6-phosphate dehydrogenase (G-6-PDH), glutamate dehydrogenase (G-6-PDH), glutamate oxalo-acetate transaminase (GOT), hexokinase (HK), lactate dehydrogenase (LDH), malic enzyme (ME) and xanthine dehydrogenase (XDH).

The bands in nine enzymes were homologous across the three populations and showed no differences. But the relative mobility of the enzyme GLUD in the Philippines population was lower than in the other two populatios and could be used for diagnostic separation.

The results confirm previous reports of differences in the relative mobility of esterase bands of the Philippines population of N. virescens from India and Sri Lanka populations on starch gel.

CONSTITUTIVE EXPRESSION OF TWO SMALL HEAT SHOCK PROTEINS DURING EMBRYOGENESIS AND IN ADULTS OF *DROSOPHILA*. R.M. Tanguay and R. Marin. Laboratoire de Génétique Cellulaire et Moléculaire, Centre de Recherches du CHUL, Ste-Foy, Qc., G1V 4G2 CANADA.

Synthesis of the small heat shock proteins (shsps) is induced by environmental stress and by the molting hormone ecdysone. During fly development, the different small hsps also show distinct developmental and tissue specific expression in the absence of stress. Here we report on the expression of hsp 23 and hsp 26 during early embryogenesis and in young and old adult flies, using whole-mount and immunohistochemical staining. During embryogenesis, an affinity-purified hsp 23 antibody stains specifically the midline precursor cells in the ventral neural cord and certain specific cells in the brain. In older embryos, hsp 23 shows expression in glial cells. In immunohistochemical assays using thin sections of embryos, a small group of cells located along the nervous system is also stained with an antibody specific for hsp 26. In young adult flies, hsp 23 is expressed in the cardia and in the cytoplasm of two different tissues: the germ lines (ovaries and testis) and the CNS (protocerebrum and thoracic ganglion). This expression decreases considerably in old adults. Hsp 26 is expressed in the CNS of young adults but only faintly expressed in old flies. In gonads, hsp 26 is present in testis and ovaries of young and older flies. Interestingly, after heat-shock at 37°C, hsp 23 and hsp 26 are visible in nuclei of nurse cells of developing ovaries and in oocytes. The specific expression of the shps in the nervous system and in the germ line tissues, and their different cellular localization in non heat-shocked and heat-shocked individuals suggest an important role for these proteins in proliferative tissues. (Supported by the Medical Research Council of Canada, FCAR and the Ministerio de Educación Español).

RECENT ADVANCES IN DEVELOPMENT OF INSECT RESISTANT TRANSGENIC PLANTS. Jay C. Pershing (700 Chesterfield Parkway North, Chesterfield, MO 63198, USA)

ENGINEERING OF BIOSAFE BACULOVIRUS RECOMBINANTS FOR INSECT CONTROL. Just M. Vlak (Department of Virology, Agricultural University, Binnenhaven 11, 6709 PD Wageningen, The Netherlands)

Baculoviruses are insect pathogens which are successfully used as biological control agents of insect pests in agriculture and forestry as alternatives to chemical insecticides. These natural viruses are insect specific and cause no hazards to other animals and to plants. A major drawback to a much wider commercial application of these viruses is their slow speed of action against insects, in particular in crops with low damage thresholds such as vegetable and horticultural crops.

By employing genetic engineering techniques a number of potentially useful baculoviruses with enhanced insecticidal activity have recently been developed. In this presentation several strategies will be discussed to secure the biosafety of genetically engineered baculoviruses. Particular emphasis will be given on the potential of deletion mutants and 'built-in' suicide mechanisms. Important parameters to evaluate are the host-range, virulence, survival and persistence of genetically modified baculoviruses, both in the laboratory and the field. This information will increase our understanding of the ecology of genetically modified baculoviruses and also allow predictions to be made about their behavior in the environment.

GENETIC ENGINEERING OF MOSQUITO VECTORS AND ITS FUTURE POTENTIAL FOR THE CONTROL OF INSECT BORNE DISEASE. J.M. Crampton, A. Warren, G. Lycett, I. Comley, M. Hughes, T.F. Knapp, P. Eggleston (Wolfson Unit of Molecular Genetics, Liverpool School of Tropical Medicine, Liverpool, UK.)

Diseases transmitted by mosquitoes pose some of the most serious health care problems in the world today. To a large extent, control of mosquito vector populations has relied on the elimination of breeding sites and the application of chemical agents. There are increasing problems associated with the use of synthetic insecticides for vector control, including the evolution of resistance, the high cost of developing and registering new insecticides and an awareness of pollution from insecticide residues. These factors have focussed attention on the need for alternative measures and a number of these based on the application of recombinant DNA and genetic engineering now seem practicable. The usefulness of transgenic technology, the direct and controlled manipulation of the mosquito genome, may have potential for population suppression. Perhaps, more interestingly, it may also provide a means for altering the vectorial capacity of insect populations.

The major requirements for producing transgenic mosquitoes will be outlined together with the progress which has been made to date. The topics covered will include the analysis of the mosquito genome, methods for microinjection of mosquito embryos, the search for new DNA vector systems for use in the mosquito system and the types of gene systems which may prove to be potential targets for genetic manipulation in the mosquito. Finally, the prospects which this type of approach has for the future control of insect borne disease will be discussed.

THE INFLUENCES OF THE NUCLEOTIDE SEQUENCES NEAR THE TRANSLATION START OF HEPATITIS B SURFACE ANTIGEN GENE ON THE GENE EXPRESSION LEVEL IN THE BACULOVIRUS EXPRESSION VECTOR SYSTEM. Chu-Fang Lo, Pe-Lan Yang, Chen-Hong Lu, Ting-Ting Wu, Nai-Yueh Tien, kuang-Hsiung Kou (Zoology Department, National Taiwan University,Taipei,China) ,Chung-Hsiung Wang (Biology Department, Fu-jen University, Taipei, Taiwan, China)

A series of AcMNPV recombinant vectors were constructed for the expression of HBVsAg . Five different sites which constitute the AcMNPV promoter region were modified with PCR, and were cloned into recombinant vector. And five recombinant vectors containing HBVsAg were successfully constructed. After cotransfection with wild type AcMNPV DNA in IPLB-SF 21AE cells, the recombinant EIA and RIA, the expression levels of five different recombinant viruses were determined and the influences of the sequences near the translational start on the expression of HBVsAg were evaluated.

EXPRESSION OF β-SUBUNIT OF HUMAN CHORIONIC GONADOTROPHIN (HCGβ) IN INSECT CELLS BY A BACULOVIRUS VECTOR

Shen Qing-xiang[1], Ren Pei-feng[2], Li Chang-lin[1] (Shanghai Institute of Cell Biology,Academia Sinica, Shanghai 200031, China[1]. Shanghai Institute of Biochemistry, Academia Sinica, Shanghai 200031,China[2])

Development of hCGβ as a vaccine against hCG is perhaps one of the most promising approaches to human fertility regulation. The expression of cDNA (579 bp) encoding hCGβ was accomplished using the baculovirus expression vector system. The gene was subcloned into a unique Sma I site of the multiple cloning region in the plasmid pVL1393, so the expression of hCGβ was under the control of the strong polyhedrin promoter. The transfer vector pVL1393-hCGβ was co-transfected into Sf9 cells with AcMNPV genomic DNA. The recombinant virus was identified and purified by several rounds of plaque hybridization. By RIA, we demonstrated that the recombinant hCGβ was expressed and secreted into medium. The maximal level of expression was achieved by day 5 postinfection, which was as high as 3.4ug/10^6 cells. The purification of rhCGβ is in process.

EXPRESSION OF HEPATITIS B VIRUS SURFACE ANTIGEN USING A BACULOVIRUS VECTOR WITH THE POLYHEDRIN GENE. Xunzhang Wang, Daifen He, Weidong Xie, Ru Chen, Qingxin Long, Zhelong Pu (Instutite of Entomology, Zhongshan University, Guangzhou 510275, China), Deming Su(Virology Research Unit, Fudan University, Shanghai 200433, China)

Using a polyhedron-positive transfer plasmid and a non-occluded (OCC^-) parental recombinant, an occluded (OCC^+) recombinant baculovirus designated TnNPV HBs85-OCC^+ was constructed which contained the gene coding for the hepatitis B virus surface antigen under the dual control of the synthetic and polyhedrin XIV promoters. Infection of Trichoplusia ni larvae with TnNPV-HBs85-OCC^+ can be introduced as a contaminant of the diet rather than the conventional baculovirus OCC- expression vector in which the recombinant viruses must be injected into the host hemocoel individually. The expression level of HBsAg gene under the control of the synthetic and polyhedrin XIV promoters in Spodoptera frugiperda cells increased by 40% compared with that of the wild-type polyhedrin promoter alone. When T. ni larvae were used with the occluded recombinant, a further increase in the expression level of HBsAg gene was obtained compared with that of the non-occluded recombinant in which the gene was under the control of the wild-type polyhedrin promoter.

CLONING AND EXPRESSION OF THE BACILLUS THURINGIENSIS SUBSP. KURSTAKI CRYSTAL PROTEIN GENE IN COTTON ENDOPHYTIC BACTERIUM, BACILLUS CEREUS BC9102. Qing-wen Zhang, Ke Luo, Yinghua Zheng (Department of Plant Protection, Biological Institute, Beijing Agricultural University. Beijing, China)

The endophytic bacterium, Bacillus cereus BC9102, isolated from cotton, might spread systemically throughout cotton plants. After its inoculation of seeds, the endophytic bacterium might be reisolated from roots, stems and leaves of cotton. This endophytic bacterium may be constructed to carry Bacillus thuringiensis endotoxin gene for insecticides against susceptible cotton insect pests. B. thuringiensis subsp. kurstaki HD-1 produced highly toxic protein crystalline inclusion to cotton bollworm, Heliothis armigera, and pink bollworm, Pectinophora gossypiella. DNA fragment of 3' end deletion of δ-endotoxin gene of B.thuringiensis subsp. kurstaki HD-1 were subcloned into pUC19 plasmid. resulting recombinant plasmids pUC TH12 and pUC TH15, respectively. Recombinant plasmid pUC TH12 was transferred into protoplasts of cotton endophytic bacterium, B. cereus BC9102. Transformants were screened by ELISA method for the producing of crystal protein in B.cereus BC9102. Five transformants showed toxic effect to larvae of H. armigera and other Lepidoptera insect pests.

A physiological model for the hormonal interaction between *Cardiochiles nigriceps* Viereck and its host *Heliothis virescens* (F.) (Hymenoptera: Braconidae - Lepidoptera: Noctuidae)

Pennacchio, F.[1], S. B. Vinson[2], T. Tanaka[3], and E. Tremblay[4]

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In the host parasitoid assoeiation *Heliothis virescens* (F.) - *Cardiochiles nigriceps* Viereck, host pupation is inhibited and the total ecdysteroid hemolymph titer is reduced compared to unparasitized larvae. The ecdysteroid titer was found to be altered by both teratocytes and a combination of venom and polydnavirus from the female wasp. However, teratocytes raised the eedysteroid titer while the virus and venom depressed it.

The virus (as calyx fluid) and venom of the parasitoid suppress the seeretory aetivity of the host prothoraeic glands, whieh exhibit redueed ability to produce ecdysone *in vitro* when stimulated by prothoraeieotropie hormone. Teratocytes result in developmental host changes similar to those observed in parasitized host larvae. However, the hemolymph eedysteroid titer is high. The high titer is composed of low levels of 20-hydroxyecdysone because teratocytes are able to convert 20-hydroxyeedysone to inactive products. A physiological model eonsidering both the maternal and embryonie host-regulatory faetors is proposed to describe the parasitoids effeet on the molting system of its host and its significanee to the parasitoid.

INHIBITION OF TESTIS-DEVELOPMENT OF LARVAL HOST BY THE PARASITOID, *COTESIA KARIYAI*. Tanaka, Toshiharu (School of Agriculture, Nagoya University, Nagoya 464, Japan), S. Yagi (National Institute of Tropical Agro-Research Center, Tsukuba, Ibaragi 305, Japan)

Braconid endoparasitoid, *C. kariyai*, regulates the physiological condition of the host to make an suitable circumstance for development of its eggs and larvae in the host by polydnavirus and venom and teratocytes. Inhibition of testis-development of the lepidopteran host seems be one of important factors for parasitoid eggs and larvae to accomplish their development within a restricted resource. Polydnavirus and venom fluid, which are injected with their eggs at the oviposition, depressed directly the testis-development during last larval host instar. The testis of day 0-unparasitized host transplanted into isolated abdomen was increased in volume by stimulation of 20-hydroxyecdysone (20HE). However, the day 0-testis, which was transplanted into the isolated abdomen after 6 hours-incubation with both polydnavirus and venom fluid, lost the response to 20HE stimulation. Both of polydnavirus and venom fluid seem directly to depress the response against 20HE of host testis.

Evasion of Immune Recognition in Insect Parasitoid-Host Interactions
*O. Schmidt and U. Theopold. Department of Crop Protection, Waite Agricultural Research Institute, Glen Osmond 5064, South Australia and Department of Microbiology, Stockholms University, S-106 91 Stockholm Sweden.

Insect endoparasitolds are able to circumvent the defense reactions of their habitual hosts. In a hymenopteran wasp species, virus-like particles, found on the egg surface are responsible for the protection against the encapsulation reaction of the host caterpillar. Some of the particle proteins are structurally and probably functionally related to host protein(s).
Host-like particle proteins coated on the egg surface might preclude recognition of the parasitoid and therefore provide a molecular explanation for the evasion of the host's defense. A mimicry function of particles is supported by the finding that antibodies against VLPs inactivate the protective function when bound to intact particles on the egg surface, leading to the encapsulation of the egg. The question remains however, whether the protection is due to the mere presence of host-like proteins on the egg surface or whether recognition or one of the steps leading to the encapsulation reaction is prevented by immune-specific properties of the VLPs. Preliminary analysis of corresponding host components suggests that the proteins which resemble the VLP-proteins are indeed part of the immune system of insects. We have recently cloned some of the genes which are coding for VLP and host proteins, by screening expression libraries with antibodies against VLPs. Our observation that some coding sequences for particle proteins crosshybridize with protein coding sequences of the host caterpillar prompted us to study their functional properties in the host using the antibodies against VLPs. One of the crossreacting proteins is structurally related to a hemolymph component in the host that is found at the surface of hemocytes and basement membranes of tissues facing the hemolymph.
Supported by the Deutsche Forschungsgemeinschaft and the NFR (Sweden).

Implications of Translation-Factor-Like Genes in the Campoletis sonorensis Polydnavirus.
Bruce A. Webb and Shirley Luckhart*, Department of Entomology, Rutgers University, New Brunswick, NJ 08903

After parasitization, polydnaviruses disrupt important insect physiological systems including the insect immune and developmental systems. However, the specific mechanisms through which these host systems are targeted are unknown. Sequence similarities of some polydnavirus genes with eukaryotic translation and splicing factors suggest that host translation or splicing may be targeted. To develop physiological assays for the selection of functionally active genes we have recently focused on alterations in host gene expression that accompany virus injection. By initially studying and identifying host-encoded genes with altered transcription, processing or translation, the mechanisms through which polydnaviruses target host physiological systems may be elucidated and allow the identification and selection of functionally active polydnavirus genes.

REGULATION OF EMBRYONIC MORPHOGENESIS IN POLYEMBRYONIC WASPS BY HOST ENDOCRINE FACTORS
Michael R. Strand (Department of Entomology, University of Wisconsin, Madison, WI 53706, U. S. A.

Studies with the polyembryonic parasitoid *Copidosoma floridanum* in its host, *Trichoplusia ni*, indicated that embryos proliferate to form 1,500 individuals in 1st-3rd instar hosts but initiate morphogenesis during the host penultimate stadium. Both embryonic events are synchronized with the host molting cycle. Proliferation and morphogenesis were arrested by ablation of the host's source of ecdysone, but could be rescued in a dose-dependent manner by injection of 20-hydroxyecdysone. The transition from proliferation to morphogenesis is due, in part, to a competency effect associated with morphogenesis. Transplantation experiments indicated that *C. floridanum* embryos must develop for 8-9 days before being competent to undergo morphogenesis. The developmental basis for this competency effect and the timing of embryonic morphogenesis may be associated with expression of ecdysteroid binding molecules during periods of embryogenesis.

THE SOURCES AND DIVERSITY OF POTENTIAL HOST REGULATORY FACTORS FROM *CARDIOCHILES NIGRICEPS*, AN ENDOPARASITIC BRACONID OF *HELIOTHIS VIRESCENS* (LEPIDOPTERA: NOCTUIDAE) LARVAE. S.B.Vinson (Dept. Entomology, Texas A&M University, College Station,TX 77843, USA)

The concept of host regulation suggests that certain aspects of the physiology and biochemistry of the host are under the control of the parasitoid's genetic program. Such an idea dictates that the parasitoid must influence the host through either the physical damage to select organs and tissues, through the release of biochemically active compounds, or through the mutualistic interaction of associated organisms.

The parasitoid *C. nigriceps* appears to influence the physiology of the host through venoms and calyx polydnavirus released by the female wasp during oviposition and by the developing progeny and associated teratocytes within the host. Although there appear to be several sources of these regulatory factors, how they differ and their functions have not been extensively explored. Some of these differences and similarities will be examined and compared.

Developmental disruption of two host species by factors from the parasitoid Microplitis demolitor. B.A. Dover, Dept. Entomology, Kansas State University, USA, M.R. Strand, Dept. Entomology, University of Wisconsin-Madison, USA.

M. demolitor polydnavirus (MdPDV) had a juvenilizing effect on both Heliothis virescens and Pseudoplusia includens. The effect of MdPDV is synergized by the presence of parasitoid venom but does not completely mimic the developmental arrest observed in hosts parasitized by M. demolitor. Developmental arrest of the host is only observed when teratocytes from the parasitoid egg are present in conjunction with MdPDV and venom. The effect of MdPDV, venom, and teratocytes on the host endocrine system will be examined.

CLONING, SEQUENCING AND EXPRESSING OF SeNPV POLYHEDRIN GENE AND MARKER RESCUE FOR POLYHEDRIN MINUS AcNPV IN SF CELLS. Yipeng Qi, Dong Wu, B. A. Federici (Dept. of Virology, Wuhan University, Wuhan 430072, China; Dept of Entomology, University of California, Riverside, CA 92521, USA)

The Spodoptera exigue NPV (SeNPV) genome has size of about 134 kb. It is necessary to construct probe vector for map of polyhedrin gene (ocu). Probe vector, mAcHV43, has been constructed with HindIII fragment (ocu gene encode sequences of AcNPV) from pGPB6874/sal and M13mp18 DNA. SeNPV ocu gene is located on ca. 1.5 kb EcoRI-U fragment using about 930 kb HindIII fragment from mAcHV 43 as probe. Recombinant plasmid pSeE312 DNA constructed with SeNPV EcoRI-U and pUC19 was co-transfected with AcNPV ocu minus DNA into SF cells. Polyhedrin of recombinant virus, vAcSeP312, were observed because of homologous recombination in vivo. Polyhedrin protein expressing by SeNPV ocu gene on AcNPV genome in SF cells was shown on SDS gel. The vAcSeP312 is able to infected T. ni larvae resulting in numerous polyhedrin assembling in fat body of the larvae. Digesting vAcSeP312 and AcNPV DNAs with HindIII and EcoRI, different patterns were shown. It is demonstrated by Southern blot that SeNPV ocu gene was integrated into AcNPV genome. SeNPV EcoRI-U from pSeE312 was subcloned into M13 mp 18 for sequencing. By using erace base deletion and ddNTP chain termination the SeNPV ocu gene had been sequenced.

INDUCTION OF PREMATURE CHROMOSOME CONDENSATION IN MOSQUITO CELLS FROM *CULEX PIPIENS PALLANS* Zhao Yuguang & Lan Minyang (Jiangsu Institute of Parasitic Diseases, Wuxi, Jiangsu 214064, China)

Premature condensed chrosome (PCC) of mosquito cells (Cpp512 cell line, established by ourselves from *Culex pipiens pallans*) was induced by fusing with mitotic Chinese Hamster Overy (CHO) cells, using 50% polyethylene glycol (PEG, MW=4000) as fusogen. The ratio of the mitotic cells to the interphase cells was 15:1. The fusion was performed at 32℃ for 2-3 min. then incubated for 1 h. The PCC morphology clearly showed 3 kinds of essential types: G1-PCC had single chromatid, the early phase was more condensed than later one; S-PCC had a 'pulverized' appearance; G2-PCC had double chromatids which were well spread and countable, just like the mitotic chromosome but much longer than the mitotic one. G2-PCC therefore could be used for high resolution chromosome studies. The PCC technique would be useful and powerful tools in mosquito cytogenetic study.

STUDIES ON GENOME STRUCTURE OF RICE STEMBORER CHILO SUPPRESSALIS (WALKER), YELLOW STEMBORER TRYPORYZA INCERTULAS (WALKER) AND LEAF FOLDER CNAPHALOCROCIS MEDINALIS (GUENÉE) [LEPIDOPTERA: PYRALIDAE] I. KARYOTYPES AND CHROMOSOME C-BANDED PROFILES. Jichao Fang and Chengwen Tu (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences. Nanjing 210014.)

Karyotypes and somatic chromosome C-banded profiles in mitotic metaphases of rice stemborer, yellow stemborer and leaf folder were respectively analyzed by means of C-banding technique. Major results were as follows: (1) sex determination of the stemborers and the leaf folder consistently was of XY type, and all X sexual chromosomes were submetacentromeric or Y telocentromeric; (2) Y chromosomes homogenously paired with partial regions of X's long arms next to the X centromeres in the both stemborers, while Y with entire X's short arm in the leaf folder during spermatocyte meiosis; (3) the karyotype of the rice stemborer was 2n= 5 pairs of autosomes(A) + XX (female) or XY (male), one pairs (No. 1) of the autosomes with metacentromeres and the others with telocentromeres; (4) the karyotype of the yellow stemborer was 2n= 6II A + XX (female) or XY (male), all the 6II A with telocentromeres; (5) the karyotype of the leaf folder was 2n= 4II A + XX (female) or XY (male), these A all with telocentromeres; and (6) C-banding patterns of the chromosome sets in the three pests were respectively established. Evolution of the chromosomes and Interspecific relationships in the pests were then discussed.

HIGHER PLANT GENES FOR INSECT RESISTANCE. D. Boulter, V. Hilder, Angharad M.R. Gatehouse, K. Powell and J.A. Gatehouse (Department of Biological Scienees, University of Durham, Science Laboratories, South Road, Durham DH1 3LE, U.K.)

The present position and future prospects for engineering genes from higher plants into crop plants (transgenics) to enhance protection against insect pests will be surveyed.

Data will be presented on a variety of genes encoding enzyme inhibitors e.g. cowpea trypsin inhibitor and wheat α-amylase inhibitor, leetins e.g. snowdrop lectin and pea lectin and enzymes e.g. bean chitinase and pea lipoxygenase, whose protein products have been shown to have insecticidal properties in diet bioassays and/or transgenic plants. Insect groups against which different proteins have been shown to be effective in the laboratory or growth room include Lepidoptera, Coleoptera, Orthoptera and Hemioptera. Limited field data is also available. Since higher plant protein protectants usually give less than 100% protection at physiological concentrations it is likely that several, each having a different mechanism of action will need to be combined in a transgenic crop; the additive effects of pea lectin and cowpea trypsin inhibitor in transgenic tobacco plants illustrates the potential of this approach.

The characteristics of higher plant resistance to insects and the advantages of mimicking natural protection as a commercial strategy will be described. Thus, in order for transgenic plants with endogenous insect resistance to partially substitute for chemical insecticides, they will need to be effective, deliver new technical advantages and be of equivalent cost to use and produce.

It is concluded that, although relatively little field data are available, natural higher plant protectants offer some advantages over chemicals and show great potential.

MOLECULAR EVOLUTION, ORGANIZATION AND EXPRESSION OF THE ACTIN GENE FAMILY IN TEPHRITID FRUIT FLIES. Mei He and David Haymer (University of Hawaii, Department of Genetics and Molecular Biology, Honolulu, HI 96822)

The Oriental fruit fly (Dacus dorsalis) and the Medfly (Ceratitis capitata)are major agricultural pests in Hawaii and other parts of the world. To initiate molecular studies, four actin genes from D. dorsalis and one from C. capitata have been isolated, characterized and sequehced. The sequenced regions include the coding, 3' and 5' flanking regions.

These sequences have been analyzed and compared with data from previously published Drosophila melanogaster actin genes. All the five genes sequenced are more closely related to the muscle specific actin genes in D. melanogaster in terms of similarity at the protein level as well as the sharing of intron positions. At the DNA level, diversity observed in the coding regions of these genes indicates a high incidence of silent mutations. In addition, analysis of codon usage in these genes indicates a different pattern of codon preference between Drosophila and the two Tephritid species. In the 3' and 5' flanking regions of the actin genes from these three species considerably less homology is detectable.

The 3' flanking regions of each gene have been subcloned. These subclones will be used as gene specific probes to locate the position of each gene on chromosomes by in situ hybridization. They will also be used to detect differential patterns of expression of each gene in a temporal and spatial manner.

TRAPS AND TSETSE POPULATION GENETICS. Jonathan K. Stiles (The International Centre of Insect Physiology and Ecology (ICIPE) P. O. Box 30772, Naiorbi, Kenya.)

Many attempts at eradicating tsetse in the past have not been very successful due to the rapid upsurge in certain cases in fly number when depression methods seize to be operative.

Many believe that the residual population which expand to precontrol levels constitute a subpopulation which is either refractory to the control operation or are of a different genetic composition. Others believe that re-invasion may be the problem. In our attempt to understand this phenomenon and to optimize tsetse control we have developed a method of marking wild and laboratory tsetse (Glossina pallidipes) generally and have assessed the impact of trap deployment in a pilot tsetse control site on specific phenotypic categories (on a monthly basis)to examine whether specific phenotypes have been lost from the gametic pool or not. We have also exmined the possibility of using this method for assessing trap efficiency for those specific categories.

Preliminary results indicate that the trapping system currently being used is effective against the whole cross section of the G. pallidipes population and there is very little evidence of selection for the phenotypes studied. However there is evidence that the drastice decline in the fly population in the suppression zone has eliminated a few rare phenotypes which may in the long term affect the gametic pool.

GENETIC AND ENVIRONMENTAL FACTORS DETERMINING THE EGG SIZE OF A SKIPPER, PARNARA GUTTATA.

Fusao Nakasuji, Shinsuke Fujioka (Faculty of Agriculture, Okayama University, Okayama 700, Japan)

The rice-plant skipper, P. guttata, has 3 generations a year and adults of the autumn generation migrate to southwest direction. The egg size of the skipper is small in the 1st and 2nd generations, but larger in the 3rd generation. The egg size variation is an adaptive trait in relation to the leaf toughness of host grasses in each generation.

Under the experimental conditions, the larger females lay smaller eggs at different densities and temperatures, however, the larger females lay larger eggs under different photoperiods. Genetically larger females lay larger eggs. Larger hatchlings from the larger eggs develop faster and upto larger adults. Heritability is high for both body size and egg size. Genotype-environment(temperature) interaction is little or none. Such a high genetic variability may bring about the phenotypic plasticity among seasons.

TARGETING SPECIFIC INSECT PESTS USING PROTEASE INHIBITORS

John T Christeller[1], Elizabeth PJ Burgess[2], Ngaire P Markwick[2], Brian D Shaw[1] and WA Laing[1].

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Protease inhibitors expressed in transgenic tobacco and tomato plants have provided resistance to a limited range of insects. The potential for extension of these observations to specific post insects in other crops is being investigated.

We screen a wide range of proteinaceous protease inhibitors for in vitro effectiveness against insect digestive enzymes. The best inhibitors are then tested in artificial insect diets for effectiveness prior to production of transgenic plants for bioassay.

This systematic approach will be described using examples of important New Zealand insects: Teleogrullus commodus (Gryllidae, Orthoptera), Wiseana cervinata (Hepialidae, Lepidoptera) and Cydia pomonella (Tortricidae, Lepidoptera).

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#1

THE MALE OF XO TYPE OF SEX DETERMINATION OF DROSOPHILA auraria COMPLEX SPECIES. Zhuo-hua Dai(Department of Biology, Peking University, Beijing 100871, China)

Metaphase chromosome configurations of Drosophila auraria complex species were examined by the Giemsa staining and C-banding method. It was unexpectedly found that the D.auraria(H_1-Ⅲ) from HangZhou, China and the D.subauraria(S-YG) from Yagishiri, Japan. Both of them were an XO type of sex determination. It was first time reported that the results of Cytogenetics and male fertility studies of the above two species: 1. The mean of relative length of the X chromosome in male larval brain cells of the stock(H_1-Ⅲ) and the stock(S-YG) were very longer than the other stocks of D.auraria(XY type) and D.subauraria(XY type). 2. There are longer the 3rd and X chromosome in D.subauraria(S-YG,XO) than in D.subauraria(S-KT4 XY), but both the stock S-KT4 and the stock S-YG were with C-banding dark staining and no difference was seen between the two stocks. 3. There are normal viability and fertility both the D.auraria(H_1-Ⅲ,XO) and D.subauraria(S-YG,XO). It can thus be assumed that the existence of XO species demonstrates that the male fertility factors have been translocated from the Y to the 3rd chromosome and to the X chromosome. Although the Y chromosome as a separate entity absent from the metaphase, yet they keep the male fertility.

#2

ETHYLMETHANE SULPHONATE INDUCED YELLOW MITE (*HEMITARSONEMUS LATUS* BANKS) RESISTANT MUTANTS ON JUTE (*CORCHORUS OLITORIUS* L. VARIETY JRO-632). P.K. Hghosh, A. Chatterjee (Centre of Advanced Study in Cell and Chromosome Research, Dept. of Botany, University of Calcutta, 35, Ballygunge Circular Road, Calcutta-700019,India)

Presoakeds seeds of Jute (*Corchorus olitorius* L. Variety JRO-632) were treated with 0.5% Ethylmethane Sulphonate (EMS) for 6 hours. Yellow Mite (Hemitarsonemus Latus Banks) resistant mutants were screened in M_3 in contrast to the normal plants. The mutants otherwise looked normal excepting the nature of yellow mite (*Hemitarsonemus Latus* Banks) resistant behaviour. A number of yield component growth parameters were recorded like plant height, basal diameter, plant spread, root length, pod per plant, seeds per pod, pod length/breadth ratio, primary branch/plant, secondary branch/plant, leaf angle, branching angle, first flowering date, 100% flowering date, total duration, % of pollen sterility and weight of 100 seeds which were found to vary from the control plant. Chromosome analysis revealed a number of aberrations like stickiness, fragmentation, polyploidy, clumping, laggard and bridge formation etc, at a very low frequency. These yellow Mite resistant Mutants gives more fibre yield with superior quality than the control plants.

#3

STUDIES ON KARYOTYPE EVOLUTION IN APHIDS: DNA CONTENT IN TWO STRAINS OF *Megoura viciae*. Manicardi G.C., Bizzaro D., Bianchi U. and Bonvicini Pagliai A.M., Dipartimento di Biologia Animale, Università di Modena, Modena, Italy.

We have studied a case of chromosome polymorphism, by aestimating the DNA content of two strains of *Megoura viciae* (Homoptera, Aphididae): one normally holocyclic, coming from Switzerland and one paracyclic, originally found in Sicily (Italy). Squashed preparations were treated with Ethidium Bromide and studied microfluorometrically. This kind of analysis carried out on spermatozoa of male obtained from the holocyclic strain put in evidence a C value of 0.48 pg. Emission values observed in mitosis of the holocyclic swiss strain (2n=10) and in mitotic plates of the sicilian paracyclic strain (2n=10/11/12/13) were completely overlapping. We are therefore turned to conclude that the variations in chromosome number found in the sicilian strain are solely due to chromosome fragmentation. Several cases of intraspecific chromosome number polymorphism have been observed in paracyclic populations. This fact fits the condition of holocentrism characterizing the aphid chromosomes and moreover it can be also explained by admitting that the lack of sexual reproduction can favour the reservation of chromosome rearrange ments which, on the contrary, would be rapidly eliminated by meiosis.

#4

KARYOTYPE ANALYSIS OF SPEMRY CELL OF SEVEN INSECT SPECIES IN SHANXI PROVINCE. Hong Xia (Shanxi Plant Protection Institute, Taiyuan 030031, China), Jie You (Tibet College of Agriculture and Animal Husbandry), Hui-li Chang (Surveillance Station Environmental protection Angenag Chanzhi)

This paper deals with karyotype analysis on spermary cells of six species of lady beetles and one species of Pentatomidae bug cells from spermary in vitro tissue were squashed with airdrying method and stained with lactic acid-acetic acid-orcein. It was found that Coccinella septempuntata L. n=10; Adalia bipunctata L. n=10; Adonia Variegata (Goeze), n=10; Propylaea japonica (Thunberg) ab. ancora n=10; Anisosticta kobensis lewis, n=10; Leis axyridis ab. conspicua n=10; Leis axyridis Var. Novemdecimsignata, n=8; Leis axyridis Var. spectabilis, n=8; Dotoycoris baccarum (Linnaeus) n=8; Sex-determination of the six kinds of ladys beetles belonged to XYp type. The two arms of Y chromosome formed a "parachute" bivelant with X. Sex-determination of Dotycoris baccarum (Linnaeus) was found to be XO type. In this work, chromosome size and arm length ratio were measured for each slide. C-banding technique was also successfully employoged for karyotyping. Data obtained from the study showed that there was evolutionary relationship among the species.

#5

METHOD TO CHROMOSOME LOCATE NEW MUTATIONS IN *CERATITIS CAPITATA* (WIED.) Miguel C. Zapater (Cátedra de Genética, Facultad de Agronomía, Universidad de Buenos Aires. 1417 Buenos Aires, Argentina)

A quick method employing three Y-linked translocations is proposed to locate any new autosomal and recesive mutation in the medfly, *Ceratitis capitata*. A series of crosses search for pseudo-linkage between sex and the mutation, indicating its chromosome location. The basis of this method lies on the new linkage relationship established by the translocation between the new mutation and the Y chromosome. The following three translocations were employed in this protocol: T:(Y;3;5). T:(Y;4) and T:(Y;2;3). The method involved the following stepts: males from the T:(Y;A)s were separately mass crossed to mutant females. Their male offspring was backcrossed to mutant females and the descendance examined. According with the chromosomal location of the mutation, 5 different combinations could result from the three crosses done. From the different combinations resulting, the chromosome location is deduced. Only few individuals have to be scored from each cross.

#6

COMPARISON OF PROMOTER ACTIVITIES BETWEEN p10-LIKE GENE AND POLYHEDRIN GENE OF BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS USING FIREFLY LUCIFERASE ASSAY. Shuichiro Tomita, Jun Kobayashi, Shigeo Imanishi (National Institute of Sericultural and Entomological Science, Tsukuba, Japan) Toshimichi Kanaya (Research Institute for Biological Science, Katakura Industries Co.,Ltd.,Matsumoto, Japan)

The baculovirus expression vector systems are now widely used for the expression of foreign genes. In most systems the polyhedrin promoter is utilized. Recently, in Autographa californica nuclear polyhedrosis virus (AcNPV), several foreign genes were expressed using the other promoters. Utilizing these promoters enables to obtain stable,cccluded recombinant viruses.

We identified the p10 gene homologue in the genome of Bombyx mori NPV (BmNPV). From this p10-like gene (PLG), we constructed a transfer vector, pBNT1, which includes the PLG promoter region for foreign gene expression. A recombinant BmNPV, P6ETL,in which the PLG was replaced by the firefly luciferase gene, was obtained by employing pBNT1. Luciferase activity was observed in P6ETL-infected NISES-BoMo-15AIIc cells, which was derived from B.mori embryos. We also obtained another recombinant virus, in which the polyhedrin gene was replaced by the luciferase gene. Using these two recombinant viruses, promoter activities of the PLG and the polyhedrin gene were compared by luciferase assay.

#7

CLONING AND EXPRESSION OF THE BACILLUS THURINGIENSIS SUBSP. KURSTAKI CRYSTAL PROTEIN GENE IN COTTON ENDOPHYTIC BACTERIUM, BACILLUS CEREUS BC9102. Qing-wen Zhang, Ke Luo, Yinghua Zheng (Department of Plant Protection, Biological Institute, Beijing Agricultural University. Beijing. China)

The endophytic bacterium, Bacillus cereus BC9102, isolated from cotton, might spread systemically throughout cotton plants. After its inoculation of seeds, the endophytic bacterium might be reisolated from roots, stems and leaves of cotton. This endophytic bacterium may be constructed to carry Bacillus thuringiensis endotoxin gene for insecticides against susceptible cotton insect pests. B. thuringiensis subsp. kurstaki HD-1 produced highly toxic protein crystalline inclusion to cotton bollworm, Heliothis armigera, and pink bollworm, Pectinophora gossypiella. DNA fragment of 3' end deletion of δ-endotoxin gene of B.thuringiensis subsp. kurstaki HD-1 were subcloned into pUC19 plasmid, resulting recombinant plasmids pUC TH12 and pUC TH15, respectively. Recombinant plasmid pUC TH12 was transferred into protoplasts of cotton endophytic bacterium, B. cereus BC9102. Transformants were screened by ELISA method for the producing of crystal protein in B.cereus BC9102. Five transformants showed toxic effect to larvae of H. armigera and other Lepidoptera insect pests.

#8

CLONING AND CHARACTERISATION OF THE ACETYCHOLINESTERASE GENE FROM *Ceratitis capitata (medfly)*

Gina Banks, I.M.B.B., P.O. B. 1527, Heraklion 711 10, Crete, Greece

Acetylcholinesterase (AChE) is the target site for carbamate and organophosphate insecticides and an altered form causes broad spectrum resistance in many insects. The AchE gene has been isolated and sequenced from two insects, *Drosophila melanogaster* (Hall and Spiere, 1986) and *Anopheles stephensi* (Malcolm and Hall, 1990). On the basis of consensus sequences between these two species, oligonucleotide primers were designed so that the counterpart sequence of the AchE gene could be isolated from medfly by means of the polymerase chain reaction technique (PCR). A 311 base pair medfly genomic DNA fragment was identified by PCR and named M_3. M_3 was sequenced and shown to contain an intron of 147 base pairs. The similarity of exon regions to the counterpart region of the *D. melanogaster* AChE gene was 86% at the amino acid level and 67% at the nucleic acid level. A medfly genomic library in EMBL3 was screened with a 13kb genomic clone was isolated. This clone was named M_{16}. A restriction map of the clone has been constructed by restriction enzyme analysis and southern blotting.

Furthermore sequence data for M_{16} shows that there is very close similarity at the amino acid level when the coding regions of the AChE gene in *D. melanogaster*, *An. stephensi* and medfly are compared.

#9

DIHYDROFOLATE REDUCTASE AND METHOTREXATE RESISTANCE IN *DROSOPHILA*. H. Hao, G.M. Tyshenko, S.L. Rancourt, V.K. Walker (Department of Biology, Queen's University, Kingston, Ontario, K7L 3N6, Canada)

Methotrexate (MTX) resistance resulting from amplification of the dihydrofolate reductase (DHFR) gene has been reported in mammalian tissue culture cells and cancer patients. To study the molecular genetic basis of MTX resistance in a *Drosophila* population as well as a selected cell line, we are attempting to clone the DHFR gene from *Drosophila*. DHFR was purified and the amino terminal sequence was determined. Oligonucleotides corresponding to the sequence were used to screen *Drosophila* genomic and cDNA libraries and as primers for DNA amplification reactions. Expression libraries were also screened with antibodies made to DHFR synthetic peptides or purified protein. In addition, DHFR genes from mouse and mosquito have been used to identify homologous sequences in *Drosophila*. The results and sequence identifications from these various cloning strategies will be discussed.

#10

EVOLUTION OF HIGHLY REPETITIVE DNA SEQUENCES AS A TOOL IN THE STUDY OF THE PHYLOGENY OF TENEBRIONIDAE (COLEOPTERA). Juan C., Pons J. & Petitpierre E. (Lab. Genetica, Dep. Biol. Amb., Fac. Ciencies, UIB, 07071 Palma de Mallorca, Spain).

Satellite DNAs are highly and tandemly repetitive DNAs present in most organisms but differing considerably in their amounts per genome. These DNA sequences vary little intraspecifically but can differ strongly between closely related species. Sequence homology for divergence comparisons between any taxonomic level can be very useful for phylogenetic considerations. We have characterized by restriction endonuclease digestion cloning and sequencing units of satellite DNA from several tenebrionid species and particularly of species belonging to the genus *Tribolium*. In general terms, the sequences of Tenebrionidae studied are very rich in A-T base pairs, between 150 and 180 base pairs (bp) in length, representing from 25 to 55% of the total genome and of pericentromeric localization mostly. *Tribolium* shows species-specific major satellite DNAs and presence of low copy number conserved satellite DNA specific of *Tenebrio molitor*.

#11

ISOLATION AND EXPRESSION OF THE ECLOSION HORMONE GENE OF THE SILKWORM, BOMBYX MORI.
Takehiko Kamito, Hideo Tanaka, Bunji Sato, Hiroshi Kataoka, Hiromichi Nagasawa, Akira Isogai and Akinori Suzuki (Department of Agricultural Chemistry, Faculty of Agriculture, The University of Tokyo, Bunkyo-ku, Tokyo 113, Japan.)

A neuropeptide hormone, eclosion hormone (EH), controls the ecdysis behavior in insect. The gene and cDNA encoding eclosion hormone (EH) of the silkworm, Bombyx mori, were isolated and sequenced. The results showed that the pre-EH molecule contains a 26-amino acid signal peptide and a 62-amino acid mature EH. The deduced amino acid sequence agreed with that previously determined by the peptide analysis. The Bombyx EH gene had at least 3 exons, and the gene organization was similar to that of Manduca EH reported previously. Primer extension and Northern hybridization analyses revealed that 0.9 kb mRNA is transcribed and it has a 66-nucleotide non-translated sequence at the 5'-end region. In situ hybridization and immunohistochemical analyses showed that the EH gene is expressed in 2 or 3 nuerosecretory cells per hemisphere in the brains of larva and pupa.

#12

RESTRICTION FRAGMENT LENGTH POLYMORPHISM (RFLP) ANALYSIS OF MITOCHONDRIAL DNA IN JAPANESE PLUSIINAE(LEPIDOPTERA:NOCTUIDAE). Masashi Nomura (Faculty of Horticulture, Chiba University. Matsudo. Chiba.271.Japan.), Takanori Kobayashi and Ken-ichi Numachi (Ocean Research Institute,University of Tokyo.Nakano. Tokyo.164.Japan.)

The systematics and relationships among species and genera of subfamily Plusiinae (Lepidoptera: Noctuidae) have evoked much discussion in recent years among researchers working on their morphological characters. Under these circumstances, we investigated their biochemical characteristics to introduce a new aspect in the systematic revision of the plusiine species. In this paper,we analyzed restriction fragment length polymorphism (RFLP) of mitochondrial DNA (mt-DNA) in several plusiine species.A procedure for isolation of mt-DNA from moths followed Chapmans and Powers(1984) with some modifications.Clude mt-DNA were not digested by restriction endonucleases, and therefore, we used ultra-centrifugation(100,000rpm;3h) in cesium chloride -ethidium bromide gradients for isolating CC (closed circular) and OC (open circular) of mt-DNA. We used 15 restriction endonucleases(6 bases length of recognition sequence) for digestion of CC mt-DNA in 10 plusiine species (8 genera: *Autographa*, *Macdunnoughia*,*Anadevidia*, *Plusia*,*Thysanoplusia*, *Acanthoplusia*, *Ctenoplusia* and *Chrysodeixis*)and calculated seguence divergence (Nei and Li, 1979) from the RFLPs. The results showed that a close relationship between genus *Autographa* and *Anadevidia* was suggested. Details of the study will be discussed.

#13
PERSISTENCE OF DNA INJECTED INTO EARLY EMBRYOS OF THE SILKWORM, *BOMBYX MORI*. Toshiki Tamura, Toshio Kanda, Kenji Yukuhiro (National Institute of Sericultural and Entomological Science, Tsukuba Ibaraki 305, Japan)

Expression of DNA injected into embryos of the silkworm, *Bombyx mori,* has been reported. However, the state of injected DNA is not so well known, except for a single report (J.-C. Prudhomme, personal communication). So, we examined more detailed features of the fate of injected DNA and analyzed factors affecting the persistence of DNA during the development of embryos.

We first compared the difference between injection of linear and supercoiled DNA using the plasmid pBR322. Both DNAs broke down very quickly after injection. A large amount of small sized DNA, which was undergoing breakdown, was observed in early embryos, and small amount of high molecular weight DNA, which was thought to be involved in incorporation into the genome, appeared only when linear DNA was injected. This high molecular weight DNA persisted rather long, without reduction in amount. When comparing total DNA, the breakdown of supercoiled DNA was slower than linear DNA; however, no high molecular weight DNA was observed. Digestion of purified DNA by restriction enzymes showed that DNA remaining after injection of supercoils only intact plasmid, and the high molecular weight DNA was not a simple concatamer of injected DNA. We also studied the effects of injection stage, point of injection, DNA concentration and different plasmids on the persistence of DNA.

#14
THE CONSTRUCTION AND SCREENING OF DNA LIBRARY OF *TRACHOGRAMMA DENDROLIMA*. Yi Weng, Xiao-lin Lu and Zhong-xiang Liu (Department of Parasitology, The Fourth Military Medical College, Xian 710032, China)

Trichogramma plays an important role in the biological control of pest of agriculture and forest, however, whose classification still relies on the morphological method at present. Recently, the cloned DNA probe method offers the advantages of specifity and sensitivity that has been able to differentiate species, subspecies, and even distinct isolates of the some insects. Therefore, we report here the cloning of DNA from *Trichogramma dendrolima*. Total genomic DNA of *T. dendrolima* was partially cleaved with restriction enzyme Sau3A and ligated into the BamHI site of plasmid pUC12 before transformation of Escherichia coli JM103 host, so *T. dendrolima* DNA library constained ampicillin and X-gal was screened by colony hybridization using ^{32}P-labeled nick-translated whole genomic DNA of *T. dendrolima*. Colonies both pTD14 and pTD28 were hybridized strongly. Following the double digestion with EcoRI and HindI, electrophoresis showed that pTD14 contains a 3.2 kb insert. Then pTD14 was labelled with bio-11-dUTP to detect preliminarily *Trichogramma* by the DNA dot hybridization assay. The result showed that pTD14 probe can hybridize with *T. dendrolima* DNA, but not with *T. evanescens* and *T. chilonis* DNA, which suggests that the cloned DNA fragment of pTD14 be specific for *T. dendrolima*. The recombinant plasmids cloned in this study will act as the valuable specific DNA probes for development of the classification and identification of *Trichogramma* in the molecular level.

#15
CONSTITUTIVE EXPRESSION OF TWO SMALL HEAT SHOCK PROTEINS DURING EMBRYOGENESIS AND IN ADULTS OF *DROSOPHILA*. R.M. Tanguay and R. Marin. Laboratoire de Génétique Cellulaire et Moléculaire, Centre de Recherches du CHUL, Ste-Foy, Qc., G1V 4G2 CANADA.

Synthesis of the small heat shock proteins (shsps) is induced by environmental stress and by the molting hormone ecdysone. During fly development, the different small hsps also show distinct developmental and tissue specific expression in the absence of stress. Here we report on the expression of hsp 23 and hsp 26 during early embryogenesis and in young and old adult flies, using whole-mount and immunohistochemical staining. During embryogenesis, an affinity-purified hsp 23 antibody stains specifically the midline precursor cells in the ventral neural cord and certain specific cells in the brain. In older embryos, hsp 23 shows expression in glial cells. In immunohistochemical assays using thin sections of embryos, a small group of cells located along the nervous system is also stained with an antibody specific for hsp 26. In young adult flies, hsp 23 is expressed in the cardia and in the cytoplasm of two different tissues: the germ lines (ovaries and testis) and the CNS (protocerebrum and thoracic ganglion). This expression decreases considerably in old adults. Hsp 26 is expressed in the CNS of young adults but only faintly expressed in old flies. In gonads, hsp 26 is present in testis and ovaries of young and older flies. Interestingly, after heat-shock at 37°C, hsp 23 and hsp 26 are visible in nuclei of nurse cells of developing ovaries and in oocytes. The specific expression of the shps in the nervous system and in the germ line tissues, and their different cellular localization in non heat-shocked and heat-shocked individuals suggest an important role for these proteins in proliferative tissues. (Supported by the Medical Research Council of Canada, FCAR and the Ministerio de Educación Español).

#16
THE PURIFICATION AND PROPERTIES OF ACETYLCHOLINESTERASE FROM DIPEREX-RESISTANT AND SUSCEPTIBLE STRAINS OF THE HOUSEFLIES. Chuan-ling Qiao, Jing Wang, Wei Quan, (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Dipterex-resistant and-susceptible strains of *Musca domestica vicina* (housefly)have been compared on the basis of their acetylcholinesterase (AchE) activity. It was found that the AchE activities was higher in the Dipterex-resistant strain (Dipt-R) than in the normal susceptible strain (NP); in male than in female housefly of the Dipterex-resistant strain and the normal susceptible strain. Different substrate specifities and a different sensitivity to inhibitors between the Dipt-R and NP strains suggest a quantitative difference in the AchE. AchE activity was found to be sensitive to the dosage of a small region of the third chromosome, 87E1-5. This work forms part of a study to clone and isolate the gene for resistance. Information on the molecular structural features and expression of a major gene for resistance will increase our understanding of the resistance mechanisms.

#17
CELL DIFFERENTIATION AND GENE EXPRESSION SITUATION. Debiao Zhao (Shanghai Institute of Cell Biology, Academia Cinica, Shanghai 200031, China)

A central issue in development biology concerns the cellular and molecular mechanisms that generate cell diversity during the embryogenesis. Although it is clear that different embryonic cells will finally differentiate into certain type of cells , the molecular mechanism that controls the cell differentiation has remained largely elusive. Combined studies of genetic and molecular approaches have revealed that continual regulatory interaction between cytoplasmic molecules and nuclei can play an important role in contolling the cell differentiation. A model will be described using Drosophila as an example, which proposes that cell differentiation is initiated by gene expression situation G or S resulting from the interaction betweeen the morphogenic determination factors and cleavage nuclei, leading to the expression of different set of zygotic genes (like hb, twi, Sxl, etc). These new gene products in cytoplasm of different blastula cells will subsequently interact with nuclei to generate new situations of gene expression (namely, SVM, SDE, GM or GF) determining again the diverse direction of cell differentiation by expressing other genes. It is this orderly, sequential changes in gene expression situation during development that accounts for cell differentiation.

#18
THE STRUCTURE OF ANTHERAEA PERNYI FIBROIN GENE: MOTIF AND PREFERENTIAL CODON USAGE. Kenji Yukuhiro, Toshio Kanda and Toshiki Tamura (National Institute of Sericultural and Entomological Science, Tsukuba Ibaraki 305, Japan)

The sequence of a fibroin cDNA from the wild silkworm, Antheraea pernyi, has been determined. This sequence contained a motif with nucleotides corresponding to polyalanine, as expected from the polypeptide sequence. The G+C content of the clone was more than 63%, which is consistent with the high content of alanine and glycine residues in A. pernyi fibroin. However, A+T was markedly rich at the third codon position compared to the first and second positions. When the four fold redundant codon position of alanine was considered, A appeared most frequently (54.5%). Such a strong preference was not seen in the glycine codon position (T:41.2%, A:29.4%). A different preference of codon usage is seen in the Bombyx mori fibroin gene, where T is used more frequently than A in the alanine codon. It is notable that a similar preference of usage to that of A. pernyi can be observed in the alanine codon of a spider dragline silk cDNA, which also contains a motif with a nucleotide sequence corresponding to polyalanine.

#19

STUDIES ON GENOME STRUCTURE OF RICE STEMBORER CHILO SUPPRESSALIS (WALKER), YELLOW STEMBORER TRYPORYZA INCERTULAS (WALKER) AND LEAF FOLDER CNAPHALOCROCIS MEDINALIS (GUENÉE) [LEPIDOPTERA: PYRALIDAE] I. KARYOTYPES AND CHROMOSOME C-BANDED PROFILES. Jichao Fang and Chengwen Tu (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences. Nanjing 210014.)

Karyotypes and somatic chromosome C-banded profiles in mitotic metaphases of rice stemborer, yellow stemborer and leaf folder were respectively analyzed by means of C-banding technique. Major results were as follows: (1) sex determination of the stemborers and the leaf folder consistently was of XY type, and all X sexual chromosomes were submetacentromeric or Y telocentromeric; (2) Y chromosomes homogenously paired with partial regions of X's long arms next to the X centromeres in the both stemborers, while Y with entire X's short arm in the leaf folder during spermatocyte meiosis; (3) the karyotype of the rice stemborer was 2n= 5 pairs of autosomes(A) + XX (female) or XY (male), one pairs (No. 1) of the autosomes with metacentromeres and the others with telocentromeres; (4) the karyotype of the yellow stemborer was 2n= 6II A + XX (female) or XY (male), all the 6II A with telocentromeres; (5) the karyotype of the leaf folder was 2n= 4II A + XX (female) or XY (male), these A all with telocentromeres; and (6) C-banding patterns of the chromosome sets in the three pests were respectively established. Evolution of the chromosomes and Interspecific relationships in the pests were then discussed.

#20

BIOCHEMICAL GENETIC VARIATION IN POPULATIONS OF THREE NABID SPECIES. James J. Grasela (University of Missouri, Columbia, M(65205), William W. M. Steiner (USDA, ARS, BCIRL, P.O. Box 7629, Research Park, Columbia, MO 65205)

Genetic variation at 15 allozyme loci in 22 geographical populations of three predaceous nabid species (Nabidae: Nabis alternatus (N.A.), Nabis roseipennis (N.R.), and Nabis americoferous (N.Am)) was analyzed using starch gel electrophoresis. Local populations were sampled by sweep netting alfalfa and clover fields located in Illinois, Kentucky, Tennessee, Texas, and the central and bootheel regions of Missouri. Genotypic frequencies were homogeneous between the sexes except in 13 N.A. populations, eight N.R. populations and two N.Am. populations. Between-population comparisons of pooled data also showed significant differences in genotype frequencies at three loci in N.A., eight in N.R., and seven in N.Am. Significant heterogeneity in genotype frequencies was found in five sympatric populations containing all three species. In contrast to most reported values, average polymorphism was higher in these insects and observed heterozygosity was atypically smaller (0.022 in N.A., 0.029 in N.R., and 0.026 in N.Am.). Most populations showed significant departure from Hardy-Weinberg equilibrium. Genetic distances revealed that populations belonging to N.A. were genetically different from the two separate population groups comprising N.R. and N.Am. In contrast, the latter two species were determined to be genetically similar.

#21

TERATOGENICS MALES OF *CIMEX LECTULARIUS* L., (HEMIPTERA, CIMICIDAE) ORIGINATED FROM NYMPHS IRRADIATED WITH GAMMA'S RAYS. Nagem, Ronaldo Luiz (Instituto de Ciências Biologicas da UFMG, Departamento de Zoologia e Colégio Técnico. 31270 Belo Horizonte, Minas Gerais-Brasil)

The effect of gamma irradiation over bedbug's nymphs of the fifth stage was observed. Bedbug's nymphs were two and eight days old and the doses used were 2.500, 5.000, 10.000, 20.000 and 40.000 r. The nymphs, originated from eggs beared in laboratory, were observed from sixty days after irradiation. After death, specimens were mounted in slides for morphological studies. The results indicated that a minimal dose of 2.500 r is sufficient to generate teratogenic males. Nymphs irradiated showed teratogenic forms with two parameres. Only the two-day-old bedbug's nymphs showed males with two identic parameres. However different parameres were observed on nymphs of two and eight days old. The dose of 40.000 r was sufficient to inhibit the development to adult stage. The results also suggest that irradiation stimulates sexual maturity in males, however 40.000 r makes the nymphs inable to feed and, consequently, develop up to the adult stage.

INSEMINATION OF DOMESTIC SILKWORM. BOMBYX MORI. WITH SEMEN FROM HETEROFAMILY. Yuan-lin Chen, Mu-yan Gui, Cheng-zhen Ren, Feng Zhou (The Cytobiology Research Department of the Xiamen University, Xiamen 361005, China), Zhi-yi Chen, Zhi-huan Luo, Tian-xi Lu, Han-ying Chen (The sericultural Research Institute, Guangdong Academy of Agricultural Sciences)

In this study, the domestic silkworm was taken as the female parent and the eri silkworm as the male one. After their hybridization by artificial insemination, three new strains of domestic silkworm had been bred from the descended variated indeivduals. The characteristics and properties of the new strains were analyzed genetically, cytologically and biochemically, and the theoretical feasibility of carrying out hybridization between different families, the genetic contribution of the sperm from a hetero-family, and the prospect of applying this means in breeding were discussed.

VS-1

Host Plant-Mediated Interactions between Herbivorous Insects and Their Natural Enemies

THE ROLE OF NATURAL ENEMIES IN SHAPING THE FEEDING NICHES OF PHYTOPHAGOUS INSECTS. Paul Gross (Department of Entomology, University of Maryland, College Park. Maryland 20742, U.S.A.)

Attempts to explain the host plant preferences, microhabitats, and feeding behaviors of herbivorous insects have focused mainly on effects of host plant chemistry and morphology. The "enemy-free space" (or "escape space") hypothesis proposes that feeding niche preferences are also influenced by the need to minimize vulnerability to natural enemies. On a community level, it predicts that if herbivore species share enemies, their niches should diverge.

I review studies that address assumptions and predictions of this hypothesis. Evidence supports the assumption that vulnerability to enemies can vary along several niche gradients (e.g., position on the plant, phenology, host plant species), but is mixed for the prediction that differences in niche safety influence niche preferences or promote niche diversification.

INTERACTIONS BETWEEN A PINE SAWFLY, ITS HOST AND NATURAL ENEMIES AS MEDIATED BY PLANT CHEMICALS Christer Björkman and Stig Larsson (Dept. Plant and Forest Protection, Swedish Univ. Agric. Sci., Box 7044, S-750 07 Uppsala, Sweden).

Diterpenoid resin acids, a major group of secondary compounds in pines (*Pinus* spp.), show considerable variation between and within trees. Here the effects of such variation on the performance and behaviour of the needle-eating sawfly *Neodiprion sertifer* (Hym., Diprionidae) is presented. In the egg stage, there was higher predation by birds on eggs laid on pines low in resin acids. In the larval stage, the effect of resin acids was either positive or negative depending on the predation pressure. In the absence of natural enemies, larvae suffered higher mortality and grew slower on pines with high resin acid concentrations. When exposed to natural enemies, larvae on high resin acid trees survived to a higher degree than larvae on trees low resin acids. The latter is explained by a positive relationship between resin acid concentration and larval defence capability. In the cocoon stage, we found no or only weak relationships between the resin acid concentration experienced as larvae and cocoon weight, resistance to parasitoids, and risk of being eaten by cocoon predators. The dual and opposing impact of resin acids suggests that the sawfly face a dilemma of conflicting demands. Responses of larvae and adult females to changes in predation pressure agreed with predictions based on the dilemma hypothesis, i.e. when predation pressure increased both larvae and adults preferred pine tissue rich in resin acids.

Do Plant Allelochemicals Create Enemy - Free Space for Leaf Beetles on Their Salicaceous Hosts? Mark R. Hardin and Michael J. Raupp, (Department of Entomology, University of Maryland, College Park, Maryland, 20742)

Several species in the family Chrysomelidae utilize allelochemicals derived from their host plants as precursors to exocrine secretions thought to function as defenses. However, variation exists in the quantities of allelochemical precursors contained in different species of plants. It has been suggested that this variation creates feeding niches that vary in their relative safety with respect to predation. This report examines evidence that the presence of allelochemicals in salicaceous trees creates enemy - free space for associated leaf beetles. Responses of predators to leaf beetles fed on willows differing in allelochemicals under laboratory and field conditions confirm the presence of feeding niches that vary in safety. Furthermore, feeding morphology and degree of specialization influence the ability of predators to successfully attack their prey. Patterns of host plant utilization by leaf beetles in the field suggest that they discriminate among hosts which vary in safety as feeding sites.

BEHAVIORAL AND CHRONIC EFFECTS OF COTTON ALLELOCHEMICALS ON THE COTTON BOLLWORM. Chen-zhu Wang, Ming-tsang Cheo, Qi-hua Yang (Department of Plant Protection, Beijing Agricultural University, Beijing 100094, China)

Behavioral and chronic effects of six cotton allelochemicals--gossypol, tannic acid, quercetin, rutin, catechin, and gallocyanidin on the cotton bollworm, Heliothis armigera(Hübner) were studied. Only gossypol was significantly deterrant and the others were not so when applied to glandless leaf discs at 1% of the dry weight of the leaf. Tannic acid and gossypol significantly reduced the relative growth rate (RGR) by 6.13% and 5.73%, relative consumption rate (RCR) by 14.05% and 7.68%, and approximate digestibility (AD) by 6.76% and 5.51% respectively; catechin significantly increased the RGR and RCR by 7.20% and 4.48% respectively. The other three had no significant effects on the RGR of larvae. Both gossypol and quercetin had dual allelochemical effects--hormesis and antibiosis. Hormesis of quercetin was stronger than that of gossypol. Tannic acid had steady retarding effects on the growth of larvae. The SLD_{50} (the concentration of compounds required to reduce larval growth by 50% expressed as percent diet) of tannic acid, gossypol, and quercetin were 0.14%, 0.32% and 0.34% respectively. When fed as a mixture of tannic acid and gossypol at higher concentrations, their antibiotic effects were additive.

Development Rate and Risk of Parasitism: A Test of the Slow Growth/High Mortality Hypothesis. Betty Benrey. Centro de Ecología, Universidad Nacional Autónoma de México, Ciudad Universitaria, MEXICO

The Slow Growth/High Mortality hypothesis predicts that slow larval growth on some host plants results in prolonged exposure to natural enemies and increased mortality. I tested this hypothesis by studying the interaction between the cabbage butterfly Pieris rapae and its larval parasitoid Cotesia glomeratus. I determined how variation in larval growth rate across four host plant species influenced parasitism rates and parasitoid performance. Parasitism rate was positively related to the larval development time of Pieris on plants of the same host species, but there was no clear relationship across host plant species. The lack of association between slow growth and high mortality across host plant species resulted from the direct effects of the host plant (probably surface chemistry or morphology) on the ability of Cotesia to locate and attack their Pieris hosts. Host plant species also indirectly influenced parasitoid fitness (survival, development and body size) by altering the "quality" of Pieris larvae as a food resource for Cotesia. Thus, host plants mediate herbivore/enemy interactions by affecting the growth rate of herbivores and the searching behavior and performance of their parasitoids.

HABITAT/PARASITOID INTERACTIONS: EFFECTS ON HERBIVORE ESCAPE. Naota Ohsaki (Entomological Laboratory, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan), Yoshibumi Sato (Kyoto College of Medical Technology, Sonobe, Kyoto 622, Japan).

Three Pieris butterflies, P. rapae, P. melete and P. napi use different sets of cruciferous larval foodplants. P. rapae is oligophagous and uses ephemeral plants. P. melete is polyphagous and uses persistent plants, as well as all of the ephemeral plants used by P. rapae. On the other hand, P. napi is locally monophagous using persistent Arabis.

All of the foodplants of P. rapae and P. melete are suitable for all three species. On the other hand, foodplants of P. napi are the least suitable for all three species.

Pieris larvae have two specialist parasitoids, a brachonid wasp Apanteles glomeratus and a tachinid fly Epicampocera succincta. In temporary habitats, P. rapae can avoid both parasitoids. In permanent habitats, however, P. rapae is heavily parasitized by both parasitoids. P. melete and P. napi, by contrast, live only in permanent habitats, where the parasitic pressure is potentially high. However, P. melete can partially avoid parasitism by killing the eggs of A. glomeratus by encapsulation, though parasitized by E. succincta. On the other hand, P. napi seems to have evolved behavioral avoidance of parasitoids by specializing on Arabis plants.

The different foodplant preferences of the three Pieris species can be interpreted as resulting from differences in the balance of a trade-off between parasitoid avoidance and the intrinsic quality of potential foodplants to Pieris species.

Host Plant-Mediated Interactions between Herbivorous Insects and Their Natural Enemies

DIET BREADTH AND NATURAL-ENEMY AVOIDANCE IN FOUR CHRYSOMELID BEETLES THAT ATTACK *SOLIDAGO* SPP. (ASTERACEAE). Hans Damman (Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6, Canada)

The manner in which an herbivorous insect feeds influences, and is influenced by, both the quality of the plant tissues they eat and their ability to escape natural enemies. Four species of chrysomelid beetles that commonly occur together on *Solidago* growing in abandoned fields near Ottawa, Canada differ in the range of leaf nutritional-qualities that they can tolerate and in their feeding behavior. *Trirhabda borealis* larvae survive exclusively on the highest quality, young leaf tissue, which permits rapid development and which seems to represent the major means of reducing vulnerability to natural enemies. At the other extreme, *Exema canadensis* larvae feed broadly on leaves of all ages and qualities, and develop most slowly. The effective protection provided against natural enemies by a case built of fecal material seems to play a central role in permitting the slow development of *Exema*. The remaining two species, *Microrhopala vittata* and *Ophraella conferta*, show developmental rates and exposures to natural enemies intermediate to those of *Trirhabda* and *Exema*.

CROP VARIETY-RELATED MORTALITY FROM NATURAL ENEMIES: INTERACTIONS IN RICE. Jiaan CHENG, Yong-gen LOU and Zeng-rong ZHU (Deaprtment of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

The interaction among rice, planthoppers including Nilaparvata lugens and Sogatella furcifera, and natural enemies at egg stage, Anagrus sp. and Cyrtorrhinus lividipennis, were studied using both experimental and simulation methods. The results showed that the effects of natural enemies on population dynamics of planthoppers could be directly and indirectly affected by rice varieties through three approaches: density-dependent effects resulted from performance of planthoppers on these varieties due to nutrition factors; preference of natural enemies to planthoppers feeding on these varieties due to semichemical factors and searching efficiency of natural enemies related to egg distridution due to physical factors. The simulation indicated that the growth rate of planthopper population could be significantly reduced through these approaches. The potential ways to improve planthopper management by incorporating these factors were also discussed.

VEGETATION STRUCTURE AND PREDATOR/HERBIVORE POPULATION DYNAMICS. Hartmut G. Döbel & Robert F. Denno. (Department of Entomology, University of Maryland, College Park, Maryland 20742, U.S.A.)

We investigated the effect of vegetation structure on spider/planthopper interactions in a North American intertidal marsh (*Spartina alterniflora*). Field observations showed that *Prokelisia* planthoppers are the major prey items of spiders. In laboratory experiments, the functional response of wolf spiders to *Prokelisia* prey changes from a type-II to a type-III curve as the habitat is made more complex in structure by adding thatch. Thus, *Prokelisia* planthoppers escaped predation more often at intermediate densities in complex-structured habitat. Experimental manipulation of vegetation structure in field plots revealed that spider density was significantly higher in complex-structured plots (twice the biomass of thatch) compared to control plots (natural biomass of thatch). Planthopper density was lower in the in the complex-structured plots than in plots with reduced architectural cornplexity. These findings suggest that the increased risk of predation due to aggregation of spiders in more complex habitats is buffered because planthoppers find refuges in structurally complex habitats. Thus, habitat structure plays an important role in mediating spider/planthopper interactions and dictates to some extent the availability of enemy-free space.

VS-2 Models as Links between Empiricism and Theory in Insect Ecology

FORGING TOOLS FOR INSECT PEST MANAGERS. Colbert, J. J. (United States Department of Agriculture-Forest Service, 180 Canfield St., Morgantown, WV 26505-3101, USA)

Models that predict insect pest population fluctuations or related damage caused by these populations may be based strictly upon empirical data or upon hypothesized theoretical models of the processes that populations undergo. Here I compare and contrast theoretically based process models and empirically based models of the gypsy moth life system. The gypsy moth, an introduced pest in North America, has been modeled by a number of researchers in attempts to answer a number of important questions related to the management of the pest and the impacts that are caused when gypsy moth reach extremely high densities. In some instances, models have shown to be useful tools for researchers to synthesize various hypotheses and demonstrate there combined effects, while in other cases, the construction of models have provided vivid demonstrations of our lack of understanding of processes that are very important to the dynamics of the insect and the impacts that are caused by dense populations.

MODELING THE EPIZOOTIOLOGY OF GYPSY MOTH NUCLEAR POLYHEDROSIS VIRUS. Joseph S. Elkinton, G. Dwyer (Dept of Entomology, University of Massachusetts, Amherst, MA, USA)

Modified Anderson-May host-pathogen models were used to simulate the within-generation dynamics of a nuclear polyhedrosis virus in gypsy moth (Lymantria dispar L) populations. The model parameters were estimated from simple field experiments and the model predictions were validated with data on naturally occurring virus epizootics. The model was coupled with a dispersion model to simulate the results of an experiment on the spatial spread of virus.

SPATIAL POPULATION MODELLING OF *HELICOVERPA SPP.* : STUDIES OF ADULT BEHAVIOUR AND MOVEMENT. Gary P. Fitt and Martin L. Dillon, CSIRO Division of Entomology, NARRABRI, NSW, AUSTRALIA, 2390

An ambitious simulation model is being developed as an aid to predicting the regional population dynamics of *Helicoverpa* spp. in multicropping systems. The model has the acronym "HEAPS" (*HElicoverpa Armigera* and *Punctigera* Simulation) and will be used to evaluate the effects of various agronomic practices on the seasonal distribution and abundance of *Helicoverpa armigera* and *H.punctigera*, and hence assist in the design and implementation of areawide management strategies.

Unlike previous models of *Helicoverpa* (MOTHZV, Helsim), HEAPS includes a spatial component. The model divides a region into a grid of square simulation units, of definable size, with population processes (oviposition, development, mortality and host phenology) simulated in each unit. Adult moths are then moved between simulation units according to a series of movement and host selection rules. The model is highly sensitive to this function and considerable research has been undertaken to quantify adult behaviours.

Phenology of adult emergence and emigration from source crops has been studied using direct observations, radar and mark-recapture. These show that low level movement is predominantly downwind and flight distance and direction are both functions of wind conditions in the model. A characteristic take-off flight occurs at dusk with low level flights between crops occuring for several hours depending on night-time temperatures. Mark-recapture studies confirm that *H. punctigera* is probably an obligate migrant and that *H. armigera* is less mobile. Flying moths alight on host crops in response to their relative attractiveness and are assumed to remain there for the remainder of their reproductive lifetime. A greater understanding of factors influencing host selection and movement is needed.

HEAPS has been designed as a flexible research tool to experiment with a diverse range of scenarios and pest management strategies. Parameter values for various modules have been derived from a range of sources and are being progressively validated. The completed model should be applicable to a variety of pests in cropping situations.

BLOWFLY COMMUNITY DYNAMICS: MODELS, EXPERIMENTS, AND COMPREHENSION

Ilkka Hanski, Dept Zoology, Univ Helsinki, P. Rautatiekatu 13, SF-00100 Helsinki, Finland

Local communities of blowflies typically consist of ca 10 species, which coexist in spite of often severe competition for the larval resource. Coexistence may be explained by aggregated spatial distribution of competing individuals. I describe the relevant models and present experimental results testing the model predictions. In a local community in southern Finland, Lucilia illustris has been consistently more abundant than L. silvarum, even though the two species are very similar biologically. A model including density-dependent diapause behaviour appeared to explain the observed differences in their abundances, but experiments testing this model failed to support it, and instead pointed to other possible mechanisms. Most recently, we have found complex non-linear responses of larval performance to density in the two species. A model including the details of larval competition, spatially aggregated distribution of larvae, and a realistic level of adult mortality, predicts coexistence and numerical dominance by L. illustris.

NON-LINEAR SENSITIVITY ANALYSIS AS A TOOL FOR EXPLANATION OF POPULATION DYNAMICS IN THE FRAME OF THE LIFE-SYSTEM CONCEPT. Sharov, Alexei A. (West Virginia University, Morgantown, WV 26505, USA)

The life-system approach is aimed at process-oriented analysis of a system including a population and its effective environment. I consider it as a theoretical base for explanation of population dynamics and as an alternative to both analytical modeling and to empirical regressions which deliberately oversimplify real ecological mechanisms. The major difficulty in application of the life-system approach was an absence of methods for theoretical analysis of complex simulation models. I propose to use a non-linear sensitivity analysis of simulation models to evaluate the role of individual ecological processes and their interactions in population dynamics. Process interactions were shown to be important in outbreak patterns of the common pine sawfly (Diprion pini L.) in Russia. Non-linear sensitivity analysis is also applied to the problem of population stability. Coefficients of M- and V-stability characterize stability of the mean level and variance of population density, respectively. Contribution of ecological processes and their interactions to these coefficients is evaluated. The ability to measure and qualify the relative importance of process interactions, which cannot be examined using linear sensitivity analysis, is the principal goal of the life-system approach.

MODELLING INSECT POPULATION DYNAMICS USING EMPIRICAL DATA

Yu.M.Svirezhev

(Institute of Atmospheric Physics, Moscow, Russia)

Reconstruction of dynamic models basing on empirical data is a typical incorrect problem, which can be solved by some regularization procedure. The same population dynamics can be produced by different mathematical models. For instance, oscillations can be generated by time delays, "predator-prey" interaction, forced oscillations of parameters etc. The problem is to select the model most adequate to reality. I suggest a method for that based on the comparison of topological invariants for models and empirical trajectories.

Another important problem of insect population dynamics is the propagation phenomena, described for instance in terms of non-linear waves. What kind of empirical data one needs to identify the wave type? The evaluation of such practically important characteristic as the propagation rate depends on the solution of this problem.

MODELLING MOVEMENT AND MORTALITY: KILLING FLIES IN THE FIELD. Brian Williams (Department of Zoology, Oxford University, South Parks Road, Oxford OX1 3PS, UK.)
Many vector borne diseases such as the African trypanosomiasis and malaria may best be controlled by controlling the vectors using odour baited traps. The effectiveness of trapping technology depends on the efficiency of the traps and on the movement patterns and population dynamics of the vectors. Mathematical models make it possible to determine the optimal trap distribution, the width of barriers needed to prevent reinvasions and the rate of advance of population fronts into uninfested areas. All of these can be related to measurable biological parameters. Models that have been developed and used in the control of tsetse flies will be discussed in relation to community based vector control in Africa.

A SIMPLIFIED GYPSY MOTH MODEL SYSTEM. Rumei Xu (Dept. Biol. Beijing Normal University, Beijing 100875, China), J.J. Colbert (USDA Forest service, Northeastern Station, P. O. Box 4360, Morgantown, WV 26505, U. S. A.)

A discrete time difference equation model system is constructed to invesitgate the intrinsic properties of the gypsy moth life system, e. g., host plant-gypsy moth population interactions, density effect, etc. In the system, the diameter growth of the stand is dependent upon maximum diameter growth, crowding due to overstocking, and defoliation caused by the gypsy moths. Gypsy moth population depends on population parameters, density-dependent survivourship and lack of foliage. After comparison, a simplified model is constructed for simulation maximum diameter growth. Crowding effect, defoliation effect, density-dependent gypsy moth survivourship, etc., are discussed in the paper. The model system can display various cyclic behaviour, i. e., 3, 4, to 6, 7 years cycles. Further approach on the model system shall be continued.

GLOBAL BEHAVIOUR AND PARAMETER ANALYSIS OF THE SIMPLIFIED GYPSY MOTH MODEL SYSTEM (SGMMS). Nan-qing Jiang, Ru-mei Xu (Dept. Biol., Beijing Normal University) & J. J. Colbert (USDA Northeastern Forest Experiment Station. USA)

Qualitative analysis of the SGMMS revealed that the trajectory of G(t+1) against G(t) on a phase plane is represented by three stage discrete equations. The eigenvalue (V) of the system is demined by four parameters: SR (sex ratio), F (female fecundity), k generation survivourship except for 4-6th instars) and A (survivourship of 4-6th instars without density effect). The global behaviour is determined by V and the gypsy moth initial density (G0). It can display stable asymptotic, stable oscillatory, unstable oscillatory including periodic behaviour and chaos.

The influence of host plant species and sensitivity of the paraters is evaluated by SG10 (accumulated numbers of gypsy moth eggs in 10 years). When foliage is in shortage, the values of SG10 for red oak, american beech, red maple and white oak has a ratio of 1 : 0.7 : 0.98 : 0.83. The sensitivity of the parameters SR, F, k, G0, a1, b1, c1, A, B and N is also discussed.

ECOLOGICAL BASIS OF RICE IPM SYSTEMS. Keizi Kiritani (Food & Fertilizer Technology Center, 14 Wenchow St., Taipei, Taiwan, China), Fusao Nakasuji (Department of Agriculture, Okayama University, Okayama, Japan)

Since rice cultivation extends from the tropics to cool temperate areas, pest species vary greatly depending on the climate. However, all the niches in rice fields are occupied by the same species or by the ecological homologues of different species. Successive crops of lowland rice can be grown in the same field without any deleterious effects. Continuous cropping of an annual crop is a characteristic of the paddy agroecosystem, which provides a habitat for both residential and migratory pests. Rice IPM should involve these two antagonistic elements as its ecological basis.

Modern agriculture has given migratory insects new opportunities for population increase, with staggered cropping of rice in the tropics, and by inadvertently destroying their natural enemies. Asynchronized planting, on the other hand, by providing natural enemies with pests as their food, may help to limit damage. Likewise, minimum tillage and direct sowing of rice in temperate areas should be studied as a IPM adapted cropping system which encourages the activity of natural enemies.

THE ECOLOGICAL BASIS OF CITRUS IPM SYSTEMS. J. Daniel Hare (Department of Entomology, University of California, Riverside, Calif., 92521 USA)

Citrus is one of the crops most heavily treated with pesticides in California because the value of the crop is strongly influenced by fruit appearance and size as well as total biomass. Substantial progress has been made in recent years to manage citrus pests with fewer pesticide applications. Much of this progress has resulted from studies designed to seek a better understanding of the actual impact of the pest on tree growth and fruit production over a range of growing conditions. Other fundametal studies have pointed out the role of the host plant on the interaction between citrus pests and their natural enemies. This has led to a better understanding of variation in the ability of natural enemies to provide effective biological control on different citrus cultivars. The importance of basic ecological studies on the design and improvement of citrus IPM systems will be illustrated with recent research on the Citrus Red Mite, *Panonychus citri* (McGregor) and the California Red Scale, *Aonidiella aurantii* Maskell.

ECOLOGICAL BASIS OF SOYBEAN IPM SYSTEMS

Marcos Kogan (IPPC, Oregon State University, Corvallis, Oregon, USA) and Antonio R. Panizzi (CNPSoja, Londrina, PR, Brazil)

Soybean is a relatively new crop in over 80 percent of the area under current cultivation. Colonization of the crop by arthropods in areas of recent introduction results in a pattern of dynamic faunal changes with new endemic species gradually adapting to exploit the available food resources. In the largest areas under cultivation in North and South America, there are still potential feeding niches open for colonization by herbivores, thus the process of colonization continues, demanding constant surveillance, rapid assessment of impact, and quick access to biological information on wild hosts and the basis of herbivore/host interactions. IPM systems have been directed primarily to 3 major pest complexes: 1) lepidopterous defoliators, 2) coleopterous defoliators, 3) hemipterous seed-feeding species. Several other complexes are locally important and require specific adaptations of the basic IPM systems. The ecological basis for development of tactical components of current IPM systems include: 1) population dynamics of key herbivore species and their natural enemies as a basis for development of predictive phenological models, economic injury levels, and assessment of the value of natural control agents; 2) life history theory that helps identify colonization potential and success of phytophagous species; 3) sampling theory that supports population dynamics research and practical scouting programs; 4) theory of herbivore/plant/natural enemy interactions that provides the basis for development of resistant varieties and assessment of interactions of resistance with biocontrol; 5) dynamics of entomopathogen epizootics that serves as basis of microbial control methods; 6) community dynamics theory that supports the interpretation of data on the interactions of multiple pests. Examples from all regions where soybean is grown will be used to illustrate the interactions between ecological theory and IPM practice and to point out critical gaps in basic ecological research that hampers achievement of higher levels of integration in current management systems.

THE ECOLOGICAL BASIS OF IPM SYSTEMS FOR OILSEED CRUCIFERS

Heikki M. T. Hokkanen, Applied Zoology Department, University of Helsinki, SF-00710 Helsinki, Finland

Growing oilseed crucifers is everywhere relatively management-intensive, due to many serious insect pest, pathogen, and weed problems. Particularly in Europe oilseed crucifers need to be treated with chemical pesticides more than most other crops. In many growing areas the agroecology of oilseed crucifers is complicated by the simultaneous growing of summer and winter varieties, sometimes of both swede and turnip rape, even mustard.

In northernmost growing areas such as Finland, the cropping system is less complicated, and the pest populations are possibly easier to manage. An integrated management program has been developed for the growing of summer turnip rape in Finland. Currently its main elements are based on the ecological knowledge of pest, parasitoid, and pathogen population dynamics; interactions between host plants, pests, and their natural enemies; pest and natural enemy behaviour; and the ecotoxicology of pesticides used in the cropping system. The agronomic practices influenced include trap cropping, conservation tillage, pesticide use, and cropping sequence design.

BIOLOGICAL AND METEOROLOGICAL ASPECTS OF PLANTHOPPER MIGRATION. Ryoiti Kisimoto (Entomology Llaboratory, Faculty of Bioresources, Mie University, Tsu, Mie, Japan 514)

Long distance migration of planthoppers stepwise from the tropics to the northern range of rice growing area in East Asia have been substantiated or hypothesized. In most species of planthoppers young macropterous adults show a strong tendency to take off after a short teneral period and fly into a light when available irrespective of their body size. But only 5 species out of more than 100 occurring in this area have been elucidated to migrate several hundreds or more km through repeated surveys on seas and lands far from the suspected migration sources. The migrants multiply on species-specific host annual grasses like rice, wheat or weeds grown near paddy field. They are characterized by their medium to small body sizes, the short egg and nymphal periods and relatively low wing-load index.

Strong SW winds, warm and humid, appearing at the near south of a frontal system in the rainy season assist the long distance movements. Circumstantial evidences suggested that the wind maxima appearing in the morning at several 100m high seems convey the migrants. The rice leaffolder, predacious mirid bugs on the planthopper eggs, the spiderlings of Tetragnatha also migrate together with planthoppers but Jassid leafhoppers are least likely to migrate.

MIGRATION OF *HELICOVERPA* SPP. FROM SEMI-ARID INLAND REGIONS TO SOUTHEASTERN AUSTRALIA. P.C. Gregg (University of New England, Armidale NSW 2351 Australia), G.P. Fitt (CSIRO Cotton Research Unit, Narrabri, NSW 2390, Australia), M.P.Zalucki (University of Queensland, St. Lucia, Queensland 4067, Australia), D.A.H.Murray (Department of Primary Industries, Toowoomba, Queensland 4350, Australia)

The major pest species of *Helicoverpa* in Australia are *H. punctigera* Wallengren and *H. armigera* (Hubner). *H. punctigera* often appears synchronously in large numbers in spring, in regions of the southeast where it does not overwinter. *H. armigera* overwinters more commonly in the southeast, but phenological data and changes in the frequency of insecticide resistance suggest that at least some of the spring populations are immigrants.

A network of pheromone and light traps has been operated throughout Australia over 4 years. Surveys for populations of larvae in inland areas have been made at frequent intervals. We have shown that large areas in the inland can act as source regions for *Helicoverpa*, especially *H. punctigera*. The key factor is rainfall in autumn and early winter, which is extremely variable. Heavy rainfall leads to extensive growth of native annual plants, especially Asteraceae and Fabaceae, and the mild temperatures of inland regions allow winter breeding.

Migration occurs when these host plants dry off in spring. Phenological modelling, synoptic backtracking and the use of markers, especially moth-borne pollen, suggest that the emigrants can reach major cropping egions in southeastern Australia. These observations are being used to develop a forecasting system for *Helicoverpa* which will assist in pest management

MIGRATION OF THE COMMON ARMYWORM *(MYTHIMNA CONVECTA)* IN EASTERN AUSTRALIA: SURVIVING IN AN ARID CONTINENT.
Garrick McDonald (Institute of Plant Sciences, Department of Agriculture, Swan Street, Burnley, Victoria, Australia 3121)

The common armyworm [*Mythimna convecta* (Walker) (Lepidoptera: Noctuidae)] is a native pest of Australia found from the high rainfall coastal regions to the arid interior. The seasonal distribution of *M. convecta* in eastern Australia coincides mostly with the predictable changes in the grassland phenology and appears to be linked to three major phases of movement: inland (westwards) during autumn; southwards in winter and spring; and to the coast (to the eastwards and southeastwards) in summer. During summer and autumn, the northern tropical grasslands flourish after rainfall, which occurs most regularly on the coast. The inland growth is terminated by severe frosts in winter, displacing newly emerged moths to the southern grasslands. During late autumn to spring these temperate grasslands provide reliable and enduring habitats for 2 generations. However, the grass invariably senesces in late spring to summer, further displacing moths to the persisting and often lush grasslands of the coast. The eastern coast provides the most likely avenue for a limited return migration to the north.

The species is also able to exploit the highly ephemeral growth of the inland, providing key source regions for subsequent inland migrations. The biological and meteorological mechanisms, which allow such opportunism, will be discussed.

LOCUST AND NOCTUID MIGRATION IN WESTERN AUSTRALIA. K.J.Walden (Western Australian Department of Agriculture, Geraldton, WA 6530, Australia)
Trapping and extensive ground surveys have revealed that a number of noctuids and acridids develop and reproduce over most of the State of Western Australian. Of particular interest are two major pest species, the native budworm, Helicoverpa punctigera, and the Australian plague locust, Chortoicetes terminifera. Adult activity of the native budworm has been studied over the past four years using blacklight traps. With the aid of day-degree summations, rainfall and wind records, events that govern changes in abundance and distribution of the native budworm have been described. The phenology of two major plagues of the Australian plague locust have been documented and with the aid of a development and survival simulation model, the progression of the plagues back-tracked to their likely origins. It is shown that upper air currents, the vehicle for migration, would be able to carry both species from the arid interior to the agricultural regions of the State. Migration is seen as an important strategy of both species for survival in diverse and sometimes harsh and unpredictable environments.

WIND AND MIGRATION BEHAVIOUS OF ARMYWORM, *Mythimna separata* (Walker) . Chen Rui-lu, Sun Ya-jie, Wang Su-yun, Zhai Bao-ping and Bao Xiang-zhi (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Jilin Province 136100, China)

In 1986, 1989 and 1991, observations on the wind speed and direction by theodolite and the flight of armyworm, *Mythimna separata* (Walker) by radar were carried out during the spring migration in northeast China. During spring migration of armyworm, frequency of the southwest wind was 65-69%. Peak flight presented during the strong southwest wind. In 1989, average wind speed was 12 m/s in 200-1000 m above ground. It showed 7 m/s higher than at 25 m. And its average wind direction turned about 45° forward from direction at 25 m above ground. The highest wind speed was located in the level 650-975 m above ground. The level the highest wind speed, the greatest volume density was present. The flight direction and speed of migrants were close to wind direction and speed. It was verify that armyworm moths immigrated downwind with southwest wind and tended to the level of higher wind speed in spring. Results in 1986 and 1991 were similarly to these. It takes a long period to form these migration behaviours and heredity genes controling these migration behaviours. It suited to utilize more energy dynamic of the wind for immigration into the new favorable habitats each generation. Wind must be considered as a main ecological factor for insect long range migration. The problem to understanding and control the behaviour of armyworm migration must be preceded by the recognition of its heredity.

INSECT MIGRATION, WEATHER, AND CLIMATE IN THE AMERICAS. Seth J. Johnson, Department of Entomology, Louisiana State University Agricultural Center, 402 Life Sciences Building, Baton Rouge, LA 70803-1710, USA

Insect migration in the temperate Americas is seasonal and in polar directions. The predominant synoptic-scale migration pathway in North America extends from the Gulf Coast states to the North Central states. It is the result of meteorological conditions that develop over the flat terrain of the Central Plains, Mississippi River drainage system and the Gulf of Mexico. In the spring a high pressure system on the east coast and a low pressure system in the Great Basin with a trailing cold front creates south to north transport on a nocturnal low level jet at 300-900 m. Many species of moths, aphids, leafhoppers, leaf beetles and other insects utilize this pathway and can be transported up to 2000 km in 1-3 days depending on wind speed. Biometeorological, radar, and mark-release-recapture studies have documented this pathway and evidence is accumulating that most of these species are not victims of a "Pied Piper" phenomenon but have a return migration by progeny of spring migrants southward in the autumn in association with continental high pressure and passage of a cold front. Mesoscale migrations are made by many different insect species in polar and east to west directions on convective winds of cold fronts and "sea-breeze fronts". Return migrations by the same individuals are made by the army cutworm between the Great Plains and Rocky Mountains and by the monarch butterfly between Canada and mountains of the Neovolcanic Plateau of Mexico. Butterflies that migrate are seasonal daytime fliers generally in polar directions within flight boundary layer not under the influence of synoptic-scale wind systems. Insect migration in the American Tropics is not well known. Some tropical migrations are associated with the rainy season and mountain-valley winds while others occur on seasonal trade winds during the dry season.

VS-4 Insect Migration: Physical Factors and Physiological Mechanisms

LONG-RANGE MIGRATION IN RELATION TO CLIMATE AND WEATHER: AFRICA AND EUROPE. D.E. Pedgley and D.R. Reynolds (Natural Resources Institute, Chatham Maritime, Chatham, Kent ME4 4TB, U.K.)

Insect migration in relation to seasonal changes in climate and the distribution of habitats on a geographical scale is reviewed for Africa and Europe, with particular emphasis on relatively long-range (tens to thousands of kilometres) windborne movements. Most of our examples concern the migrations of phytophagous insects, where movements to new breeding sites are a response to host plant phenology, which in turn is a response to the seasonality of climate. Seasonality is determined largely by temperature and daylength in the area poleward of the subtropical deserts (i.e. in the Mediterranean and temperate climatic zones) and by rainfall in the area equatorward of the deserts (the steppe, savanna and rain-forest zones of the tropics). Migrations within and between these areas are often dominated by the weather at the time of flight, particularly the strength and direction of the prevailing wind. Examples are discussed, but for many taxa the occurrence of long-range migration, the role of the wind and, in the case of pest species, the consequences for developing management strategies, are presently unknown. A greatly improved understanding would result from the application of existing research techniques.

The Effect of Vertical Zonation of Weakly Flying Insects on the Direction of Long distance Movement in the Planetary Boundary Layer. Michael E. Irwin, Illinois Natural History Survey and University of Illinois, 607 E. Peabody, Champaign, IL 61820. Scott A. Isard, Department of Geography, University of Illinois, 607 S. Mathews, Urbana, IL 61801

We currently lack the ability to forecast types, numbers, destinations, and arrival dates of important pests and their natural enemies so that pest management programs can be initiated. The ability to predict the movement of pest genotypes, including pesticide-resistant genotypes and host plant resistance-breaking genotypes, into areas that are otherwise free of them is also critical for initiation IPM programs.

Long-distance movements of weakly flying insects can be divided into three important components: take-off and events leading to take-off, horizontal translation, and descent including events leading to colonization. Horizontal translation in atmospheric motion systems dictates migration pathways and thus their destinations. Airstreams at different altitudes within the Planetary Boundary Layer have distinct trajectories and a wide range of velocities. Therefore, insects at different altitudes within a vertical column of air may originate from different locations. Sophisticated trajectory models are available to track and predict atmospheric movements, but two categories of inputs, the altitude at which insects are being transported and the length of time that insects remain airborne, are required to convert these routines into models that truly track insects. This talk addresses the first category of inputs, meteorological factors that govern the vertical zonation of weakly flying insects in migratory flight within the Planetary Boundary Layer. Insects were captured with isokinetic helicopter-borne traps concurrent with radiosonde temperature, wind speed, wind direction, humidity, and pressure data. We are in the process of rigorously establishing relationships between these important meteorological factors and the atmospheric layering of weakly flying insects. Part of this goal is to understand changes in insect concentrations on diel scales under a range of synoptic weather patterns that are commonly experienced during the growing season in the northcentral United States.

RELATIONSHIP BETWEEN WINDBORNE MIGRATION OF RICE PLANTHOPPERS AND THE LOW-LEVEL JET STREAM DURING THE BAI-U SEASON. T. Watanabe and K. Sogawa (Lab. of Pest Management Systems, Kyushu National Agricultural Experiment Station, Nishigoshi, Kumamoto, 861-11, Japan)

The long range migration of rice planthoppers, Nilaparvata lugens and Sogatella furcifera, was considered in relation to the monsoonic climate in East Asia. The planthoppers make 1000-2000 km long migration from southern China to Japan in Bai-u season. Low-level jet streams (LLJETs), intensified southwesterly air current which appears occasionally in lower troposphere 200 to 300 km south of the Bai-u front, are deeply concerned with the overseas immigrations of the planthoppers in Japan in Bai-u season. Close correlations between the development of LLJETs faster than 10 m/s (20 knots) on 850 mb surface and the immigration of planthoppers, are applied for the practical monitoring of windborne planthopper invasion into Japan. Geographic distributions of the immigrants in central China and Japan are also related to the localization of LLJETs.

THE OCCURRENCE AND MIGRATION OF RICE ARMYWORM, *Pseudaletia separata*, IN KOREA. Ki-Baik Uhm (Dept. of Entomology, Agricultural Science Institute, R. D. A., Suwon 441-707, Korea), and Joon-Ho Lee (Div. of Appl. Entoml., Dept. of Agricultural Biology, Seoul National Univ., Suwon 441-744, Korea).

Outbreaks of the rice armyworm, *Pseudaletia separata* Walker, have been observed every several years in pasture, rice, and other grain crops in Korea. This insect is suspected to be a migrant from overseas because it is not observed to overwinter, and is usually first collected by light traps in Dae-Heuksan-do, a south-western tip island, in Korea. To understand spatial-temporal dynamics of long-range migration of this insect, the moth populations have been monitored with light traps at 148 forecasting units throughout the country from 1987 through 1991. Immigration of the rice armyworm usually took place from mid-May through late June, which is about one month earlier than planthopper's immigration time. Also, the main invaded area by the rice armyworm were central parts of Korea(Kyung-gi and Kang-won provinces) which were not invaded much by immigrating planthoppers. The patterns of invasion, ① spatial occurrence, ② temporal occurrence, and ③ magnitude, are currently being analyzed. Also, various physical factors such as weather and biological factors which are important in regulating the rice armyworm migration are currently being studied.

Regulation of migration in Helicoverpa armigera: genetic and environmental factors. John Colvin (Natural Resources Institute, Central Avenue, Chatham Maritime, Chatham ME4 4TB, U.K.)

Migration by *Helicoverpa armigera* is thought to occur pre-reproductively and so the pre-reproductive period (PRP) represents the time window in which migratory behaviour can take place. Genetic and environmental factors were examined for their influence on the PRP. Neither high temperatures (>30°C) nor high vapour-pressure deficits (>23 mm Hg) lengthened the PRP. Availability of sugar solution, however, was found to have a marked influence on the PRP. The PRP distributions of Indian and Malawian female *H. armigera* were found to be significantly different. A sib-analysis experiment confirmed the genetic influence on the female PRP and suggested an X-linked mode of inheritance. A selection experiment was carried out on the basis of female PRP only, to produce both an early- and late-maturing line of females. After two generations of selection the PRP distributions of the males in the two lines were significantly different, indicating that the same group of genes controls the rate of reproductive maturation in both sexes. These findings are discussed in relation to the migratory behaviour of *H. armigera*.

HABITAT HETEROGENEITY AS A TEMPLATE FOR MIGRATORY CAPACITY IN INSECTS: EVIDENCE FROM THE FIELD. Kenneth Wilson (School of Biological Sciences, University of Wales - Bangor, Gwynedd, LL57 2UW, UK).

Recent theoretical studies have clearly demonstrated the potential of habitat heterogeneity to influence the life-histories of animals and plants. One trait (or suite of traits) that is assumed to be intimately related to the temporal and spatial stability of the environment is the capacity to migrate.

This paper will (i) identify studies that demonstrate differences between populations of insects in their capacity to migrate, (ii) examine the evidence suggesting that these differences are genetical in origin, (iii) determine the possible importance of habitat structure in maintaining this genetical variation, and (iv) as an example, present evidence that genetically-determined differences in migratory capacity between outbreak populations of the African armyworm moth (Spodoptera exempta) are the result of variation in the degree of habitat heterogeneity.

OPERATIONAL ASPECTS OF FORECASTING MIGRANT PESTS

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The object of forecasting migrant pests is to improve the decisions associated with controlling them. In order to provide appropriate forecast information, it is first necessary to identify the decision makers, their objectives and the options available to them. The type of forecast can then be specified by its timing, resolution and accuracy. Timing is when the decision has to be made. The resolution of a forecast is how precisely it predicts the time, location and size of a pest population. The accuracy is a measure of how closely the forecast matches subsequent events. The type of forecast required and the biology of the pest determine what events must be forecast. For short term forecasts it may not be necessary to forecast migration of the pest. In practice the type of forecast issued is constrained by what is possible. Forecasts are based on current data, historical data, knowledge about the behaviour of the system, and forecast of other variables such as weather. For various reasons the information from these four areas is imperfect, reducing the level of the forecast accuracy possible. Thus trade-offs become necessary, for example between accuracy and resolution: the higher the degree of resolution, the less accurate the forecast will become.
The accuracy of the forecast is one factor contributing to the value of a forecasting system. One way to evaluate a forecasting service is from the forecast recipients viewpoint. The benefit might be in reduced expected costs, or in reduced risk. The value of a forecast is also determined by the ability of a recipient to use the forecast information.
The above aspects of forecasting are discussed in relation to armyworm forecasting in East Africa, and aphid forecasting in the U.K.

Remote sensing and Geographic Information Systems (GIS) for determining the seasonal distribution of habitats of migrant insects.

T.P. Robinson. *Department of Geography, University of Reading, Whiteknights, P.O. Box 277, Reading RG6 2AB U.K.*

The technologies of GIS and remote sensing are finding more and more applications in pest control. These vary in scale from observation of the insects themselves, using entomological radar (Riley *et al.*, 1983), to broad scale monitoring of environmental conditions conducive to the upsurge of insect pests, using meteorological satellite data (Hielkema *et al.*, 1986). These techniques are considered particularly relevant to migrant pests due to the vast areas which require monitoring.

The approaches adopted are reviewed for three migrant pests: the desert locust *Schistocera gregaria*, the Australian plague locust *Chortoicetes terminifera* and the African armyworm *Spodoptera exempta*. For these pests, critical environmental variables which have been estimated from satellite remote sensing include vegetation, rainfall and soil moisture.

The seasonal distribution of habitat suitability for *S. exempta* population development, in terms of vegetation and temperature, is modelled within a GIS framework. Vegetation is estimated using NOAA-AVHRR NDVI data. Temperature is estimated by interpolation of climatological statistics using a DEM.

The potential of these techniques for improving the forecasting and control of migrant pests is assessed.

THE PHYSIOLOGICAL AND REPRODUCTIVE STATUS OF THE NATURAL MIGRATORY POPULATIONS. Zhang Xiaoxi, (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China)

The physiological and reproductive status of the natural populations were summerized. The idea of "Oogenesis-flight syndrome" is frequently used to explain the physiological mechanism underlying migration which was supposed as the existing of the opposite physiological corelationship between flight and reproduction. Many of the migratory insect species belonged to Johnson's Type I, such as Brown planthopper, Armyworms, Rice leaf roller, Milkweed bug *etc.* usually conformed with it. However in contrast, when migration is associated with adult diapause, inter-reproductive flights, or inter-flights between food and breeding habitats, the migratory flight and reproductive development will be linked as the balance of evolution in some migrant species, such as Ladybirds, Scarabs and Locusts. Some new evidence has revealed that the same hormone may stimulate both flight and oogenesis and this has led to a suggestion that ideally both flight and reproductive fitness could be maximized in the newly colonized habitat. Comparison were made on the flight capability and reproductive development in some Noctuids and Pyralids which indicated that the characteristic of reproductive development is the main differences between the resident and migrant insects.

PHYSIOLOGICAL MECHANISMS CONTROLLING MIGRATORY POTENTIAL. Jeremy N. McNeil (Département de biologie, Université Laval, Ste. Foy, P. Q., Canada, G1K 7P4)

Migration is a component of the life history of many insect species that are confronted with predictable and unpredictable changes in habitat. Species that deploy migration as a strategy to cope with the different forms of habitat change must integrate the external cues (e.g. temperature, photoperiod, humidity, food quality and quantity, population density) in order to initiate the appropriate physiological changes required for migratory flight.

This presentation will be divided into two sections. The first will examine our current understanding of how age and different environmental conditions may affect levels of juvenile hormone, adipokinetic hormone and octopamine, thereby influencing different aspects associated with flight and migration. The second section will use our present knowledge as a point of departure to suggest avenues of future multidisciplinary research which should provide better insight into the physiological processes influencing migratory behaviour.

AERODYNAMICS, ENERGETICS, AND REPRODUCTIVE CONSTRAINTS OF MIGRATORY FLIGHT IN INSECTS. Robert Dudley (Department of Zoology, University of Texas, Austin, TX 78712, U.S.A.)

Migration by flight requires extraordinary energetic expenditure by insects, yet in most cases the magnitude of this expenditure is unknown. Power curves that relate the power requirements of flight to forward airspeed can be estimated from aerodynamic and biomechanical analyses of wing flapping. A newly developed method permits direct measurements of natural airspeeds and the energy balance of diurnally migrating Lepidoptera; metabolic rates may be estimated indirectly. Diurnal migratory flight within the boundary layer is an effective strategy for relatively large, fast-flying insects such as butterflies. Such flight, however, may impose significant thermoregulatory demands, particularly in the tropics. The flight-oögenesis syndrome displayed by many insect migrants may in part be a consequence of biomechanical constraints, in particular the nonlinear increase with body mass of the mechanical power required to fly. Additional aerodynamic considerations such as decreased maneuverability may seriously limit egg development by migrating females. Flight behavior and the physiological ecology of migration are virtually unexplored in most tropical insects. The extensive, visible, and highly accessible migrations of tropical butterflies are particularly amenable to physiological and biomechanical analyses of flight.

RECENT ADVANCES IN RESEARCH ON MIGRATION AND PREDICTION OF RICE PEST NILAPARVATA LUGENS (STAL) IN CHINA. Xia-nian Cheng, Hai-kou Wang, Bao-hua Zhou (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China).

The brown planthopper (BPH) migrates northward 4-5 times a year. Mass migration of macropterous adults is synchronised with the approaching maturity of rice in infested areas. Continual south-west wind favoures northward migrations in Spring and Summer. Eight outbreak regions are identified in China. A schematic diagram was presented showing the hypothetical pathways of the seasonal migrations of BPH. The study in recent years, using a high frequency (8 mm wavelength) radar and a net suspended from a kytoon, confirms that long distance return migrations occurs in the area of Nanjing in mid and late September, with BPH being carried on the prevailing north-easterly wind towards the autumn infestation and overwintering areas of the species. The results show that after mass take-off in the late afternoon or dusk, the migrants fly for several hours during the evening, and often form a dense layer at heights between about 400-1000m above ground. These layers often have well-defined ceilings corresponding to an air temperature of about 16°C. The authors also collected a vast amount of population dynamic data in different localities obtained by light traps and field surveys and analysed the BPH immigrations in June and July from 1978 to 1983 at some sites in the Yangtze Delta by a numerical trajectory analysis scheme to estimate the pathways of BPH transportation in the lowest atomosphere (ca 1500 m). The models were run at height of 1500 m by using radio sounding data at 850hpa isobaric level under 7 time parameter matches to identify the possible sources of the BPH. The trajectory analysis strongly supports the hypothesis for the pathway of BPH migration in eastern China. These studies also are the modelling basis of mid-longterm prediction for BPH.

FORECASTING LOCUST OUTBREAKS AND MIGRATIONS. M. Lecoq (PRIFAS, BP5035, 34032 Montpellier, France.) The importance of population displacements in giving rise to locust invasions no longer has to be demonstrated. For numerous species, these displacements are a regular phenomenon and are an adaptation to seasonal changes in their natural environment. They are, moreover, the origin of the important and sudden concentrations of solitary populations which can lead very rapidly to the phenomenon of gregarisation among certain species, contributing in this way to the ease with which plague upsurges start.

An understanding of what causes these displacements is of the greatest importance if one is to be in a position to follow, and genuinely to forecast population movements which could lead to potentially dangerous situations.

For many species (African migratory locust, the Senegalese grasshopper), the concept of an optimum ecology has allowed key factors of population dynamics and displacements to be determined thereby enabling these phenomena to be modelled, and the criteria for monitoring and the prevention of invasions to be developed. The reliability of these systems is currently limited by the meteorological data that are available.

For the desert locust, research continues on improving current monitoring systems. Many approaches are followed in parallel: modelling population dynamics on a synoptic scale, following ecological conditions favourable to reproduction by satellite observations, using geographic information systems and expert systems to rationalise and to facilitate the use of data acquired on the subject over several decades.

MIGRATION OF MYTHIMNA SEPARATA WALKER, TO JAPAN: WEATHER FACTORS LEADING TO SUDDEN OUTBREAKS. Kazuo HIRAI (National Agriculture Research Center, Tsukuba 305, JAPAN)

Mythimna separata, a migrant species with a characterisitic habit of "ascending flight", overwinters in warmer west Japan with low larval density. Invasion of the adults, big and small, took place annualy in association with the movement of low air pressure from east China through the Sea of Japan to Northeast. However, The outbreak has been observed once every several years. Forecasting mass immigration in early summer is very important for the understanding of larval outbreaks in early summer. Correlations between meteorological factors of winter season in overwintering areas and armyworm overwintering success between 1958 and 1991 were looked for, hoping to use them to forecast mass immigration years. Outbreaks occurred in years in which ① January/February weather was warmer, less rainy, than the 34-year average, ② the aridity index was smaller than the average, and ③ weather in December and March was warm and dry without heavy rain and extreme cold. And the movement of low air pressure is a must for migration during the beginning of June. In northeastern part of Honshu, moreover, when over sixteen female adults were caught per molasses trap per night in June, larval outbreaks occurred over a very wide area one month later. Notice that the sex-pheromone trap did not work in trapping mass-immigrated populations efficiently.

MIGRATION, WEATHER, AND CLIMATE: OVERVIEW AND SYNTHESIS. V. A. Drake (Department of Physics, University College, University of New South Wales, Northcott Drive, Campbell, A.C.T. 2601, Australia.)

Migrant insects are able to exploit resources that vary in quality over time by successively relocating themselves into new habitats as these become suitable and then abandoning them as the habitat quality declines. Weather, climate, and climatic fluctuations are among the most important factors producing variability in habitat quality, and they also directly influence the migration process itself. Migrant life histories and behaviours are therefore very considerably determined, directly or indirectly, by weather and climate patterns, and the variability of these patterns, over a population's geographical range.

Accumulating evidence on insect migrations and their relation to weather phenomena in many different parts of the world allows some generalisations to be made. Each geographical region has its own set of geomorphological constraints (coastlines, mountain ranges, etc) and its own climate, with its particular patterns of temperature, wind, and rainfall variations and variability. The migration systems that evolve within each region are a product both of this physical environment and of the vegetation, competitor, and natural-enemy populations that coexist within it.

Drawing especially on observations presented by symposium speakers, the paper identifies the many types of influence that weather and climate factors have on migrant insects, and examines the ways in which particular migratory behaviours and life histories represent adaptations to them.

FORECASTING MIGRANT PESTS. Joyce I. Magor (Pest Management Division, Natural Resources Institute, Chatham Maritime, Kent ME4 4TB, Kent, U.K.)

Forecasts are prepared by extrapolating current events into the future by analogy with past developments and by understanding and simulating mechanisms governing change. Techniques described for acquiring, archiving, processing data and disseminating forecasts by earlier speakers and in literature are reviewed in relation to their operational application.

Methods are assessed for their ability to provide control units and or farmers with long-term forecasts to organise funds, staff and materials to match the severity of the coming season's campaign and to be updated and amended later in the season to direct staff to specific targets which may be of short duration.

Constraints experienced in running forecasting systems on an international or inter-state scale which matches the insects' mobility are discussed.

Similarities and contrasts between forecasting methods chosen with insect behaviour and the agroecosystems involved are sought.

INSECT MIGRATION: PHYSICAL FACTORS AND PHYSIOLOGICAL MECHANISMS. R.A. Farrow (Division of Entomology, CSIRO, ACT 2601, Australia), A.G. Gatehouse (School of Biological Sciences, University of Wales-Bangor, Gwynedd LL57 2UW, U.K.)
Aerial migration enables insect populations to track the shifting pattern of favourable habitats across space and time, by achieving displacements ranging from a few to thousands of kilometres. The pattern of habitat availability depends on abiotic (geography, climate, etc.) and biotic (host-plant phenology, natural enemies, etc.) factors. Winds have a major impact on the track and destination of airborne migrants; some winds can transport migrants downwind to new habitats but others are less favourable and migrants then tend to fly on chosen headings within their flight boundary layer. These abiotic and biotic factors constitute the ecological mould which shapes the evolution of migratory strategies and the arena within which they must be implemented.

Reliable environmental cues anticipating changes in habitat quality, either in existing habitats or with respect to the creation of new habitats, may or may not be present; where they are, responses to them, fine-tuning migration to habitat condition, have evolved; where they are not, genetic variation in migratory potential (including distance and direction travelled), maintained by changes in habitat distribution, provides a mechanism for tracking those changes. The fitness of the resulting migratory phenotypes depends on behavioural, physiological and biochemical adaptations (the "migration syndrome") which integrate migration with reproduction in the life cycle and which provide for and reconcile their competing energetic demands.

This paper concludes the symposium by focussing on recent advances in our understanding of the ecological context and physiological mechanisms of insect migration and by identifying oustanding gaps in our knowledge. We assess their implications for our response to the challenge presented by migratory pests.

SPERM COMPETITION AND SEXUAL BEHAVIOUR IN THE ORTHOPTERA WITH INTRODUCTORY REMARKS ON THE SYMPOSIUM. Darryl T. Gwynne (Zoology Department, Erindale College, University of Toronto, Mississauga, Ontario L5L 1C6, CANADA)

This talk will examine behavioural/ecological predictions about confidence of paternity or patterns of sperm competition particularly in Orthopterans in which males feed their mates. Particularly relevant are: the prediction that confidence of paternity covaries with male investment; and the prediction that behavioural paternity assurance mechanisms should evolve. Sperm competition in insects in general will be discussed, stressing the need for (i) studies that use relevant features of mating biology in sperm competition experiments, (ii) more information on variation in sperm competition patterns within species and (iii) research on the mechanisms of sperm competition.

SPERM COMPETITION IN THE MELON FLY. Yosiaki Itô (Entomological Laboratory, Nagoya University, Nagoya 464-01 Japan), Masaaki Yamagishi and Hiroyuki Kuba (Okinawa Prefectural Fruit Fly Eradication Office, Maji, Naha 902 Japan)

Full understanding of the sperm competition, including sperm displacement, inactivation of sperm of previous males and inhibition of female remating, is necessary for further development of the sterile insect release method, which has been successfully applied to eradicate the melon fly Bactrocera (= Dacus) cucurbitae from Japan. As the melon fly females mate many times and free sperm are reserved in spermathecae, sperm mixing takes place. Repeated copulations of females with normal and sterilized males showed that P2 values rose with elongation of mating intervals. This was not due to exhaustion of previous male's sperm due to fertilization and/or its related process, but to short longevity of sperm in the spermathecae. Copulation of melon flies lasts 8 to 10 hr, but 4 hr was enough for completion of sperm transfer. Copulation duration less than 3 hr did not inhibit female remating but that more than 8 hr did. Experiment using spermless males showed that existence of sperm is not a major factor of the inhibition of remating. These facts suggest that melon fly males introduce substance (possibly from accessory glands) which inhibit female remating after the sperm transfer.

INDIVIDUAL VARIATION IN SPERM COMPETITION SUCCESS OF YELLOW DUNG FLIES, *SCATOPHAGA STERCORARIA*. L.W. Simmons (Department of Zoology, The University of Western Australia, Nedlands, WA 6009, Australia), G.A. Parker (Department of Environmental and Evolutionary Biology, University of Liverpool, L69 3BX, UK).

Intraspecific variation in the proportion of offspring sired by the second male to mate with a female (P_2) is an aspect of sperm competition which has received little attention. For male dung flies P_2 values were dependent both on the relative size and copula durations of competing males. When copula duration was held constant, the success of an individual male increased as his body size, relative to the first male, increased. We interrupted copulations of "large" and "small" second males. The data fit well to a model of sperm displacement in which sperm mix quickly within the sperm stores. Furthermore they show that "large" males have a greater rate of sperm displacement than "small" males. The levels of prey availability during testis maturation influence a male's success in sperm competition although mating history does not. These data are used to assess more accurately the optimization of copula duration by natural selection.

SPERMATOPHORE INVESTMENT AND SPERM PRECEDENCE IN BUSH CRICKETS (Orthoptera: Tettigoniidae). K.Vahed. Behaviour and Ecology Research Group, Department of Life Science, University of Nottingham, University Park, Nottingham NG7 2RD, U.K.

The sperm precedence pattern of bush crickets (Tettigoniidae), has been little studied. It is of particular interest as males of certain species produce a large gelatinous spermatophylax attached to the sperm-containing portion of the spermatophore. Gwynne in 1984 argued that in insects, males of species which invest heavily in each mating would be expected to develop a means of increasing their confidence of paternity. He predicted that these species should show high levels of last-male sperm precedence. I used the sterile male technique to compare the sperm precedence pattern of the bush crickets, *Leptophyes punctatissima* and *L.laticauda*, which greatly differ in their degree of spermatophylax investment. Contrary to Gwynne's prediction *L.punctatissima*, the less heavily investing species, has a higher level of last- male sperm precedence than *L.laticauda*. The latter species shows pronounced first-male sperm precedence, which is unusual amongst insects. Comparing these results to other sperm precedence studies on ensiferans, I argue that the mechanism of first-male sperm precedence in certain tettigoniids is intrinsically linked to the evolutionary enlargement of the spermatophylax as a means of facilitating the transfer of large sperm loads in the context of sperm competition.

A MALE ACCESSORY GLAND PEPTIDE THAT INHIBITS REMATING AND ENHANCES OVULATION OF FEMALE *DROSOPHILA*. T. Aigaki (Department of Experimental Biology, Tokyo Metropolitan Institute of Gerontology, Itabashi, Tokyo 173, Japan), I. Fleishmann, P. S. Chen and E. Kubli (Zoological Institute, University of Zurich-Irchel, Winterthurerstr. 190, CH-8057, Zurich, Switzerland).

Drosophila females change their reproductive behavior upon mating. Mated females reject courting males and lay eggs much faster than virgins. We have shown that a male accessory gland peptide (sex-peptide) that is transfered to the female during mating plays a critical role in the induction of post-mating behavior. Transgenic virgin females carring a fusion gene that had a hsp70 promoter fused to the sex-peptide cDNA showed the same behavioral changes upon heat induction. The effects of sex-peptide lasted only one day, which is considerably shorter than that of natural mating. However, the effects could be prolonged when the peptide was expressed constitutively in a virgin female, suggesting that it is not just a trigger but is capable of maintaining the physiological state of mated female.

THE ROLE OF THE SPHRAGIS AS A VISUAL DETERRENT TO COPULATION ATTEMPTS IN CRESSIDA CRESSIDA (LEPIDOPTERA: PAPILIONIDAE). A. G. Orr (Department of Biology, University Brunei Darussalam Bandar Seri Begawan 3186 BRUNEI)

During copulation, males of *Cressida cressida* produce a large, conspicuous external mating plug termed a sphragis. The primary function of this structure is to physically prevent females remating by permanently sealing the ostium bursae. However,the large size and conspicuous form of the sphragis may also enable males to visually detect it and to refrain from wasted copulation attempts with plugged females, thus saving time and energy for males and freeing females from molestation while ovipositing. This hypothesis is supported by observations of mating behaviour, which indicate that males normally pursue, capture and mate with unplugged females without prior courtship and by a series of experiments which test male responses to females with intact sphragides and completely or partially removed sphragides.

SPATIAL AND TEMPORAL DYNAMICS OF THE GYPSY MOTH IN MICHIGAN: A LANDSCAPE PERSPECTIVE. Stuart H. Gage (Entomology Department, Michigan State University, East Lansing, MI 48824, U.S.A.)

Population density of the gypsy moth, *Lymantria dispar*, increased dramatically in Michigan during the period 1985-1991. In anticipation of this, a monitoring program was established in 1985 to monitor spatial change in adult male moths based on catch in pheromone baited traps. This trapping program consisted of a grid of 3500 permanent sites. Total catch of male moths in each trap represents an estimate of moth intensity at each of the grid point locations. To estimate the spatial distribution of gypsy moths, a continuous surface was computed based on counts of males captured in traps during the moth flight period.

Overlays of digital maps of moth distribution, tree species complexes and gypsy moth caused defoliation using a geographic information system has provided quantitative relationships between moth catch and defoliation, thus providing insight into the pheromone trap as a valuable tool for efficient estimates of gypsy moth. This information provides a tool for assessing risk by combining forest susceptibility, insect population level and defoliation. Data collected at each permanent site also provides a unique time series of moth catch to rates of change in local moth estimates.

This database, the associated tools and analytical methodology provides insight into the assessment of ecological risk over large and diverse landscapes.

PREDICTING THE DISTRIBUTION OF TSETSE FLIES USING CLIMATIC, VEGETATION AND REMOTELY SENSED DATA. Brian Williams (Department of Zoology, Oxford University, South Parks Road, Oxford OX1 3PS, UK)

The effective control of vector borne diseases in Africa depends on our knowledge of their distribution and abundance. In remote and inaccessible regions it is difficult to obtain reliable data on the ground. However, recent advances in computing, and the increasing availability of remotely sensed data acquired using satellites make it possible to determine climate and vegetation reasonably accurately. From estimates of temperature, rainfall and vegetation we can begin to make reliable estimates of the suitability of different areas for vectors of disease.

Climatic and vegetation data for Zimbabwe are used to fit the historical distribution of tsetse flies in that country and to develop an efficient methodology for analyzing such data. The fitted model is then used to predict the distribution of tsetse flies in other parts of Africa. The potential and limitations of such procedures are discussed.

ARTHROPOD FALLOUT ON MOUNT ST. HELENS AS AN INDEX OF THE DIVERSITY OF ARTHROPOD DISPERSAL. John S. Edwards and Patrick M. Sugg (Zoology, NJ-15 University of Washington, Seattle, Washington 98195, U.S.A.)

The 1980 eruption of Mount St. Helens generated a landscape of ca. 50 km^2 north of the cone in which all biota was destroyed. The subsequent arrival of arthropods was monitored by means of pitfall traps, window traps and fallout collectors set in the pyroclastic deposits at three locations (elevations 1000-1200 m).

The cumulative total of immigrant arthropod families (spiders and insects) from 1981 through 1983 was at least 141, representing 17 orders. The overall average arthropod fallout deposition rate between 1983 and 1985 was 4.99 mg m^{-2} day^{-1}. Resolution to species level has been obtained for spiders, Neuroptera, several families of beetles, and ants. There is an average of about 10 species/families from this selection, indicating that on the order of 1400 species of arthropod were taken at a minimum of several kilometers from potential source populations. This is a conservative estimate of the total diversity of dispersers. Of the 62 species of carabid beetle arriving at the site, 22 have established breeding populations. Other successful coleopteran colonists include a tenebrionid and an agyrtid. Of the 25 species of arriving spiders, 5 are breeding. All other arrivals are potential prey for the pioneer colonists. The data emphasize the prevalence of arthropod dispersal at the landscape scale.

DYNAMICS OF INSECT COMPLEXES IN AGRICULTURE AND UNCULTIVATED HABITATS IN A COTTON GROWING AREA IN CHINA. Li Dianmo. (The Institute of Zoology, Chinese Academy of Science, Beijing, China. 100080.)

The purpose of this research is to observe and model the effects of diverse landscapes in agricultural fields on the spatial and temporal dynamics of pests and natural enemies and to propose a new design of agroecosystem structure to improve regional pest management programs. This paper deals with the spatial and temporal dynamics on insects in mono-cropped and multi-cropped fields. The original data was collected from the experimental fields in Heilong Gang cotton area of northern China.

These fields are classified into different levels of complexity: mono-cropped cotton, multi-cropped cotton and wheat and multi-cropped cotton and mung bean. The abundance of major cotton pests and natural enemies were recorded in different fields through time.

A new design of this project is proposed which will focus on application of geographic information systems to map these diverse agricultural landscapes and their associate pests, natural enemies, microweather and soil fertility. This new design will provide insight into the understanding of the relation between pest outbreaks, biological control and landscape structure.

ECOLOGICAL STRATEGIES OF THREE *ATHALIA* SAWFLIES (HYMENOPTERA: TENTHREDINIDAE) FEEDING ON CRUCIFEROUS PLANTS IN THE SAME AREA.
Koukichi Nagasaka (Laboratory of Entomology, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan)

Three sawfly species, *Athalia japonica*, *A. rosae*, *A. infumata*, feeding on cruciferous plants, coexist in Japan. To understand their ecological strategies for habitat use, I compared various aspects of their life histories: spatio-temporal distribution pattern of population, host plant choice, diapause and movement pattern of adults.

The three sawflies differed in various aspects of life histories though they fed on the same crucifers. *A. japonica* occurred in spring and autumn, and diapaused in summer. It fed primarily on *Cardamine* plants, which developed new leaves in spring and autumn growing in the stable environment. *A. rosae*, which fed on cultivated plants, occurred from spring to autumn. Its adults seemed to migrate among habitats to seek for the young plants. *A. infumata* occurred from spring to autumn in low density. It fed primarily on *Rorippa indica*, which grew in unstable environment. Its adults seemed to disperse locally to seek for such temporary host. Thus, the three *Athalia* sawflies had different ecological strategies, which could be explained as adaptation to the life histories of their respective primary host-plants.

THE ROLE OF ADJACENT HABITATS IN THE POPULATION DYNAMICS AND MANAGEMENT OF ONION MAGGOT. *Dean L. Haynes.* Michigan State University, East Lansing, Michigan. 48824 USA.

By addressing control of the onion maggot as a system design-management problem it is possible to evaluate alternative designs in which spatial consideration can be given to specific biological components. The increased use of pesticides have systematically replaced many of these spatial components and allowed simplification of the agricultural production system. Reduced use of pesticide without a concomitant effort to replace the displaced structure will cause the system to collapse or greatly increase pest losses.

The structural analysis of the onion maggot system reveals the complexity of the interactions and emphasizes the importance of managing the biodiversity of a agriculture production system. Understanding the dynamics of the spatial relationships of components in an ecosystem will greatly increase the number of non pesticide management options available to IPM programs. In this presentation four natural enemies of the onion maggot are analyzed for spatial management options.

SPATIAL MOVEMENTS OF HOSTS AND PARASITOIDS WITHIN A FIELD INTERACTION. T.H. Jones, M.P. Hassell and H.C.J. Godfray, Department of Biology and NERC Centre for Population Biology, Imperial College, Silwood Park, Ascot, Berks. SL5 7PY UK.

The movement of a tephritid fly, Terellia ruficauda and its parasitoids are investigated in a field of Marsh Thistle, Cirsium palustre. Individual marking of the insects enables rate and extent of movement to be determined. Population models tend to assume complete host and parasitoid mixing, with redispersion without reference to areas originally occupied. Using data collected over a period of three years this study illustrates that for this particular interaction, the degree of host mixing is markedly less than that of parasitoid mixing. The implications for population dynamics will be discussed.

VS-7 Insect Demography: Theory and Practical Use

TWO-SEX DEMOGRAPHY. Hsin Chi. (Department of Entomology, National Chung-Hsing University, Taichung, Taiwan 40227, China)

The development of two-sex demography is critical to theoretical ecology because of differences in the developmental and survival rates of the sexes. Two-sex demography also has important practical applications in insect pest management since both sexes are often economically destructive. For most insects and mites species, an age-stage, two-sex demographic analysis can be used to account for variable development rates in both sexes. However, if the offspring sex ratio is dependent on the age of reproducing females, a more general analysis based on the age-stage structure should be undertaken for each sex (or reproductive form), especially since the sex ratio of a population reaching stable age-stage distribution can be different from the primary sex ratio. Expectation of life and reproductive values calculated from an age-stage, two-sex life table reveal the distinction among stages and between sexes. For a proper inclusion of density dependency, the variable density effects among stages and between sexes are taken into consideration by weighting the age-stage specific food consumption rate for both sexes. Moreover, the age-stage specific fecundity is dependent on the relative density of males and females. In two-sex demography, the variable development rate, survival rate, fecundity and sex ratio are the major variability factors among generations and cohorts.

GENETIC CONSIDERATIONS IN DEMOGRAPHY. Wayne M. Getz, (Department of Entomology and Division of Biological Control, University of California, Berkeley, CA 94720, USA).

Anthropogenic modifications of environments alter selective pressures and induce changes in the genetic structure of populations: the application of pesticides being a well-known example of this. The response of populations to this type of selection usually relies on classical population genetics models which do not include ecological and demographic factors. Here I discuss the application of models to ecogenetic questions associated with the response of age-structured populations to harvesting and the competitive advantage of parasitoid populations that have biased sex ratios.

DEMOGRAPHY OF INSECT INVASIONS. James R. Carey, (Department of Entomology, University of California, Davis 95616 USA).

This paper is divided into three broad parts. First, I examine demographic aspects of the four main phases of insect invasion including: i)Introduction--arrival of individuals from a source region;ii)Colonization--completion of one reproductive cycle; iii)Naturalization--microadjustment of the population to the local conditions; and iv)Spread--dispersal from the original source to widespread establishment of the population. Second, I discuss how small populations like those found in the early stages of invasion differ from larger ones. Biological differences include genetic and behavioral and demographic differences include degrees of demographic and environmental risks. Third, I bring these and other basic concepts of invasion biology to bear on analysis of tephritid fruit fly populations in California.

LOGINS, A POCKET DEVICE USED IN THE FIELD FOR DATA LOGGING OF CROP GROWTH, INSECT DISTRIBUTION AND ABUNDANCE. Zuo-rui Shen, Guang-mei Zhang (Department of Plant Protection), Jian-De Mei, Sheng-jin Shi (Computer Centre, Beijing Agricultrual University, Beijing 100094, Chian)

The data logger, LOGINS has been designed for logging data from a field investigation on insects and crops. Being set up peculiarly for aphids on wheat, this device can record following data: sampling date, weather status (temperature, humidity, etc.), wheat growth (height and number of leaves), plant health (yes-or-no of virus infection), aphid population (numbers of alate and apterous adults, nymphs, and mummies), and numbers of predators and parasitoids. The conventional hand-written and paper-recorded way often cause and consume much time, especially when the weather is rainy, windy or cold. Such problems now have been solved by LOGINS. Made with a one-chip microcomputer, it is specified as: 24Kb memory, 500g weight, $15\times10\times5$ cm^3 size, one screen and 12 keys set in its face-plate, and driven by AC or DC (3 pieces of the #5 batteries). This device can calculate means for above data and print them out with a microprinter. In addition, with a built-in interface, it can transfer the data into an IPM PC compatible computer. A program for accessing these data into a database management system has already been written in a hybrid form of BASIC and assembly languages, so that the database can be made immediately in this computer once the data transferred.

DEMOGRAPHY OF PEST CONTROL - EVALUATION OF THE EFFECTIVENESS OF THE FACTORS. Xiongfei Pang(South China Agricultural University,Guangzhou,510642, CHINA)

By means of the life tables grouped by stages and effecting factors and the mathematical model of the index of population trend,and index of population control(IPC),exclusion analysis method,addition analysis method, interference analysis method are suggested to evaluate the general effect of natural enemies,and the interaction with the insecticides,plant resistance and the effect of release of biological agents etc. The IPC,used as a numerical "operator",is helpful to study the control of pest insects.

Insect Life-Cycle Polymorphism: Theory, Evolution and Ecological Consequences for Seasonality and Diapause Control

VS-8

DIVERSITY AND INTEGRATION OF LIFE CYCLE CONTROLS IN INSECTS
H.V. Danks (Biological Survey of Canada (Terrestrial Arthropods), Canadian Museum of Nature, Ottawa, Ontario, Canada, K1P 6P4)

An ecological view of insect life cycles provides a broad context for the polymorphism and polyphenism that characterize many such life cycles. Selective forces are diverse; so are environmental factors available for use in the proximate control of development. Consequently, adaptations that budget time represent trade-offs among different objectives, and different ways of achieving temporal control.

The resulting complexity of life cycles in insects can best be understood by emphasizing their continuity as integrated pathways of development. Such integrated systems achieve a balance between seasonal synchrony, flexibility, and variability. Life cycles can be considered to comprise a series of decision points, each of which leads to a particular route of development, for example pupation or continued larval development, and diapause or nondiapause. "Polymorphic" responses reflect the fact that even in a single species more than one alternative route may be advantageous, depending on environmental circumstances.

THE INFLUENCE OF TEMPERATURE ON WING DIMORPHISM IN MYZUS PERSICAE AND LIPAPHIS ERYSIMI. LIU Shu-sheng, WU Xiao-jing (Department of Plant Protection, Zhejiang Agricultural University, HANGZHOU 310029, China)

The influence of temperature on wing dimorphism in the virginoporae of Myzus persicae and Lipaphis erysimi was examined by experiments under constant and natural temperature regimes as well as systematic sampling of field populations. The results demonstrate that low temperature promotes, while high temperature tends to suppress, the development of wings, and this promotive effect of low temperature is much stronger in M. persicae than that in L. erysimi. Observations with M. persicae on development stages sensetive to temperature show that temperatures experienced by both the mothers and the young nymphs influence the wing development in the offspring, i.e., the control is both prenatal and postnatal. According to the results from this study and other relevant reports in the literature, we propose that temperature is an important factor that should receive more attention than hitherto in the study of the relationships between environmental factors and wing dimorphism in aphids.

WING DIMORPHISM AND MIGRATION OF BROWN PLANTHOPPER, NILAPARVATA LUGENS STÅL. GUo-rui Wu , Xiao-ping Yu, Ling-you Tao (Institute of Plant Protection, Zhejiang Academy of Agric. Sciences, Hangzhou 310021, China)

The brown planthopper(BPH) is an international migrant, tropics such as Vietnam is its original source land and temperate such as China is its immigrated land.

There are some morphological and physiological differences in populations from different regions. The field population in tropics always is brachypterous except at mature period of rice but that in temperate often is macropterous. The brachypterous wing seems to be controlled by a single pair of dominant genes in tropics, but it is more complicated and seems to be controlled by polygenes.

The same ecological factors play different roles in the two different regions sometimes. For example, natural enemy is a key factor in tropics but a belated effort in China. The heavy rain is negative in tropics but rainfall is positive in China. Drought causes the increase of population in tropics but inhibit it in China. The 'biotypes' shift fast in tropics but change slowly in China.

If we get necessary information previously, we can predict the migration dynamics of BPH in China even from Vietnam early. We can predict its population in lower Yangtse River Basin basing on the initial immigrants in GuangXi province from Vietnam.

LIFE-CYCLE POLYMORPHISM, GEOGRAPHIC AND SEASONAL VARIATIONS IN A RICE GRASSHOPPER.
Yoshikazu Ando (Laboratory of Entomology, Faculty of Agriculture, Hirosaki University, Hirosaki 036, Japan)

Oxya yezoensis is a univoltine rice grasshopper in the Japanese islands. The adult size collected in the field increases from north to south and is correlated negatively with latitude and positively with annual mean temperature. This tendency persists in the progeny reared in the laboratory. The northern small grasshoppers mature earlier than the southern larger ones. The number of larval instars varies geographically, being 4 or 5 in Sapporo (43.1°N), 5 or 6 in Hirosaki (40.6°N) and from 5 to 7 in northern Kyushu (33.8°N). In the same latitude, the number of larval instars varies with the photoperiod during the 1st and 2nd instars: it increases under long day conditions compared under short day conditions.

The geographic and seasonal variations in adult size seem to represent adaptation to the local heat units.

LATITUDINAL AND SEASONAL CONTROL OF DIAPAUSE AND DEVELOPMENT IN THE ORIENTAL MIGRATORY LOCUST, LOCUSTA MIGRATORIA, IN JAPAN. Tanaka, Seiji (Laboratory of Insect Growth and Reproduction, National Institute of Sericultural and Entomological Science, Tsukuba, Ibaraki, 305 Japan).

The "Tonosama Batta", Locusta migratoria, commonly occurs throughout the Japanese archipelago ranging from 24°N to 44°N. It is univoltine in the north, bivoltine in the middle, and multivoltine in the southern areas. To understand the geographic and seasonal adaptation of the life cycles in this species, we collected locusts from different localities and examined their developmental characteristics under lab conditions. In the present paper, I will describe the geographic profile of life cycles of this species in Japan, based on our results and those published by others. To determine the genetic basis for development and diapause, some strains with different diapause characteristics were reciprocally crossed. The results are consistent with the idea that diapause is under polygenic control.

Diapause serves as a means to cope with adverse seasons in many insects. In L. migratoria, it seems to be used for seasonal as well as geographic adaptation. To understand the significance of diapause in this species, we determined the incidence of diapause in a field population and tested if eggs would survive the winter without diapause. The results suggest that eggs deposited late in the fall fail to attain the diapause stage before winter but many can overwinter and hatch in the following spring.

LATITUDINAL PATTERNS OF VOLTINISM, DIAPAUSE, HOST PLANT SELECTION AND GENE FLOW IN NORTH AMERICAN SWALLOWTAIL BUTTERFLIES. J. Mark Scriber (Department of Entomology, Michigan State University, East Lansing, Michigan, 48824, U.S.A.)

The Tiger swallowtail butterflies, Papilio canadensis and P. glaucus have a combined geographic range from Florida to Alaska in North America. No single host plant species occurs across this large area, and very different bioclimatic regimes are also encountered, ranging from sub-tropical to arctic (boreal). Photoperiodic sensitivity for facultative diapause has been demonstrated, and sex-linkage is involved in the obligate diapausing northern populations. Similar, sex-linkage of allozymes and oviposition preferences have been observed in these Papilio species. The interaction of seasonal thermal unit accumulations with voltinism and diapause characteristics of different latitudinal populations will be discussed in relation to the specificity of host plant selection by ovipositing females.

Insect Life-Cycle Polymorphism: Theory, Evolution and Ecological Consequences for Seasonality and Diapause Control

15 POPULATIONS OF PROTOHERMES (MEGALOPTERA): EFFECTS OF PREY SIZE AND TEMPERATURE.

Fumio Hayashi
(Dept. Biology, Tokyo Metropolitan University, Minamiosawa 1-1, Hachioji, Tokyo 192-03, Japan)

Life history of Protohermes, a predatory aquatic insect at larval stages, was compared between 15 streams of Japan and Taiwan. Prey availability and annual temperature regimes were also assessed in each stream.

Although larval morphologies did not differ between populations, the body size at maturity greatly changed between populations. There was a tendency that dwarfism occurred in the stream where the density of large prey was low. The larval period differed between populations (1 to 3 years), and the emergence season was also different. Stream temperature was one of the most important factors affecting these larval growth rates and seasonal timings of emergence.

Relative importance of prey availability and temperature affecting the life history of predators will be discussed.

POLYMORPHIC LIFE-CYCLES WITH TWO SEASONAL TYPES OF DIAPAUSE.

Cornelia Grüner and Sinzo Masaki, Hirosaki University, Hirosaki 036, Japan

Dormancy during winter and activity during the warmer season is the usual type of life-cycle in the temperate regions. Some insect species can, however, enter dormancy also in the warm season. This type of dormancy may increase the life-cycle variability. The polyvoltine noctuid Mamestra brassicae undergoes only hibernation diapause in the northern part of its range but the spring generation enters aestivation in the southern part as well. This may result in only two generations per year growing in spring and autumn, respectively, even in warmer districts. Between the two extremes, a cline in the incidence and intensity of summer diapause exists, and intermediate populations are polymorphic with respect to summer diapause. Selection pressure would act on the daylength threshold for summer diapause through the relative survival rate of not only aestivating pupae themselves but also their progeny, because the timing for winter diapause in the latter depends on the date of their larval development that is related to the emergence time of the parent pupae. Thus summer diapause may serve as an adaptive mechanism ensuring hibernation.

VARIATION OF CARABID LIFE CYCLES ALONG CLIMATIC GRADIENTS: AN ADAPTIVE PERSPECTIVE.

Teiji Sota (Department of Microbiology, Saga Medical School, Nabeshima, Saga, 849 Japan)

Most temperate carabid beetles are univoltine and either of spring breeder without larval diapause or autumn breeder with larval hibernation diapause (Thiele 1977). These life cycles may have originated from adaptation to particular habitat conditions in the tropical and subtropical zones (Paarmann 1979). Toward higher altitude or latitude, autumn breeders show more geographical variation in seasonal life cycles than spring breeders, including disappearance of summer diapause and change from univoltine to semivoltine life cycle. The proportion of species with larval hibernation, which are descendants of autumn breeders, is greater in cooler localities (Andersen 1984), and evolution of larval diapause seems unlikely in the descendants of spring breeders. Thus, larval diapause of autumn breeders may be one of preadapted traits to live in habitats with short season for larval development. In addition, adult survival and reproduction for more than two years, which are common in many carabid beetles, may effectively compensate for limited reproduction in each year under harsh climatic conditions. Combination of larval hibernation diapause and long adult life may be important for carabids to extend their range toward cooler habitats. Some models for life history variation in the carabids will be presented.

VARIATION IN THE LIFE HISTORY CHARACTERISTICS OF STAPHYLINOIDEA (COL.) LIVING IN AN UNPREDICTABLE ENVIRONMENT.

Topp, W. (Zool. Inst. Univ. Köln, Physiologische Ökologie, D-5000 Köln 41)

In the temperate zone of Europe, rove beetles represent a species rich family which dominate in the litter layer of the soil. Most species exhibit characteristic life cycle strategies which contribute to the segregation of sympatric species and are the prerequisites for reproduction throughout the whole year. Species which hibernate and reproduce in spring co-occur with species which aestivate and reproduce in autumn. Differences occur not only between species but also within species. Two of the Staphylinoidea are described in detail: *Atheta fungi* (Grav.) is bivoltine when the summer temperatures do not deviate from the mean but may be univoltine in a cool summer or even produce three generations per year when the summer temperatures exceed the mean values. Heritability of diapause intensity is high. In contrast, *Catops nigricans* Spence is obligatory univoltine irrespective of the annual temperatures. Phenotypic variablity within populations remains extremely high in subsequent generations. In the families studied, the range of diapause intensity is about 70% of the range found within a population. Heritability of diapause intensity is low.

CONTROL OF ALTERNATE FLIGHT YEAR ACTIVITIES IN HIGH ALPINE RINGLET BUTTERFLIES (*EREBIA*, *SATYRIDAE*) AND BURNET MOTHS (*ZYGAENA*, *ZYGAENIDAE*) FROM TEMPERATE ENVIRONMENTS.

W. Wipking & C. Mengelkoch (Zoological Institute, Dept. of Physiol. Ecol., Weyertal 119, D-5000 Köln 41 (Germany)).

Most Ringlet butterflies of the high alpine zone are characterized by a two-year developmental cycle. The growing seasons are so short during 1-3 summer months, that probably most of the larvae hibernate twice by diapause reactions. Since 1918 main seasonal flight periods have only been observed in odd years. In the intervening years only few specimens occurred. The flight periods of odd years can not exclusively be explained by the semivoltine cycle. Samples of field collected larvae were mainly invaded by parasitoids in even years. It has to be tested, if these biannual fluctuations of parasitoid frequencies can steadily control the predominating biannual reproductive activity of semivoltine species.

On the contrary, Burnet moths from temperate environments are abundant every year. They can enter repeatedly in a facultative diapause on different decolorized larval instars (stages L_3D-$L_{10}D$). Consequently some individuals skip one or more reproduction periods, so that the generation time may range between one to four years and overlap even between siblings. Consequently, more or less similar numbers of moths occur every year irrespective of the weather conditions. Temperature dependent stage-specific threshold photoperiods control induction, maintenance and termination of diapause processes in these moths. In experiments with photoperiods below the critical daylength, the duration of both non-diapause instars (from L_1-stage onwards) and pre-diapause instars were prolonged. During these stages, Ecdyson titer peaks (Etp; RIA) were stage-specifically shifted to later phases. In these experiments pooled larvae were used, which would enter diapause on stages $L_3D \rightarrow L_5D$. Thus, 3 cohorts of Etp occured in a chronological order, which might be related to variability in diapause induction. "Late" peaks were frequent, when in control experiments the larvae especially molted into the diapause morph in the young L_3D-instars. "Early" peaks resulted in additional non-diapause instars and diapause induction later on (stages: $L_{5,6}D$).

SEASONAL PLASTICITY AND LIFE-CYCLE ADAPTATIONS IN BUTTERFLIES.

Sören Nylin (Department of Zoology, University of Stockholm, S-106 91 Stockholm, Sweden.

I report results from studies on life-history adaptations in butterflies, especially Polygonia c-album, Pararge aegeria and Pieris napi. Variation in the development time of individuals should reflect differences in the importance of a short development time, if a short development time is associated with costs. Life-history theory would generally assume this cost to be a trade-off with adult size/weight. Predictions regarding variation in development time and size was tested using "split-brood" techniques to obtain population level estimates of individual reaction norms (gene-environment interactions). Individuals destined for the diapause pathway took longer to develop than those in the same brood destined for reproduction the same season, and females took longer than males. P. aegeria and P. c-album, but not P. napi, also varied development time within pathways as a quantitative response to photoperiods indicating the progression of the season. There was strong plasticity in growth- and developmental rates behind most of the variation in development times, rather than a trade-off with size, which could account for inconsistencies with predictions from life-history theory. I conclude that it is often profitable to view growth rates and other life-history traits as "chosen" by the insect rather than passively given by the environment, and hence to apply the methods of behavioural ecology to the study of insect life-histories.

Insect Life-Cycle Polymorphism: Theory, Evolution and Ecological Consequences for Seasonality and Diapause Control

POPULATION DYNAMICS IN INSECTS WITH PROLONGED DIAPAUSE

Ilkka Hanski, Dept Zoology, Univ Helsinki, P. Rautatiekatu 13, SF-00100 Helsinki, Finland

Whenever population density affects either the induction or the termination of diapause, or when there is significant variation in the diapause behaviour of individuals for other reasons, there is a possibility for a complex interaction between the individual-level process of diapause behaviour and the population-level process of population dynamics. Modelling of either population dynamics or diapause behaviour without taking into account the other may lead to misleading conclusions. I describe the conceptual basis and some models of population dynamics with prolonged and other forms of extra long diapause. The empirical examples include pine sawflies, blowflies, and fungivorous flies.

STUDY ON THE VARIANT COMPONENT STRUCTURE OF THEEST ZYMOGRAME IN POPULATIONS OF THEBROWN PLANTHOPPER.

Bo Liu, Xiao-chuan Song, Xue-ya Yin, Ping Li (Institute of Plant Protection, Fujian Academy of Agricultural Science, Fuzhou, 350013,China)

The present paper dealt with the polymorphism of EST isozyme in populations of the brown planthopper in the periodd of the rice growing. The results showed that the model type of isozymogram contented 3 bands, these were A, B, C. The values of RF for band A,B,C were 0.4102, 0.4709, 0.5042 respectly. There were 4 zymogram types formes from 3 bands, named type I with A and B bands absent,type II with A band absent, type III with B band absent,type VI with all bands existant.The Population of the brown planthopper in the periods of rice growing differed in the type conbination. At the beginning of the population setting up, the rate of type I was lower, the value was 0.46. During thepopulation developing, the rate of type I was up to 0.6 . At the late of rice growth when the brown planthopper was migrating the rate of type I rised greatlyto 0.9. The different conbinations of the zymogram in the population were alse found in the various places, under the black light, in the base of rice plant and the cage for artificially rearing the brown plant hopper.

EVOLUTION AND GENETIC ARCHITECTURE OF LIFE HISTORY IN THE PITCHER-PLANT MOSQUITO, WYEOMYIA SMITHII.

William E. Bradshaw Christina M. Holzapfel, and Jeffrey J. Hard (Department of Biology, University of Oregon, Eugene, Oregon 97403, USA)

The evolutionary trajectory of W. smithii in North America has paralleled geographic gradients of density-dependent development and climate. Preadult development time under conditions favoring direct development varies among populations but independently of geography; critical photoperiod tracks geography very closely. Thus, these two traits have evolved independently of one another along the ecoclimatic gradient of North America. Yet, a significant genetic correlation between critical photoperiod and development time persists within populations. Consequently, the independent evolution of development time and critical photoperiod has occurred despite and not because of the underlying genetic correlations. Differentiation of photoperiodic response has involved an increase of additive genetic variance over a gradient of directional selection and reflects a predominating influence of epistatic interactions over composite additive and dominance effects. We propose that the persistent genetic correlations between development time and critical photoperiod and the increase in additive genetic variance in the latter relates to sequential founder events during the adaptive radiation of W. smithii.

DEVELOPMENT OF BPH BIOTYPES IN MEKONG DELTA.

Luong Minh Chau (Plant Protection Department, Cuulong Delta Rice Research Institute, Omon, Haugiang, Vietnam)

After hopperburn epidermic in 1977-1978, BPH biotype 2 developed everywhere in Mekong Delta, a lot of biotype 2 resistant varieties as IR36, IR42, NN6A, NN7A, NN8A, NN9A, OM80, OM86 etc... were introduced to farmers for controlling BPH. Because of different natural adaptive selections, the virulence of BPH in Mekong Delta has increased higher than one of biotype 2 and its reactions also were different on differential-check varieties. But, development timing of BPH biotype in Mekong Delta was longer than compared to other places one from five to ten years for a new biotype population. Otherwise, reactions of different populations in different local were not similar, therefore, there were geographical biotypes of BPH in somewhere of Mekong Delta.

A SEARCH FOR A COMMON PHYSIOLOGICAL BACKGROUND OF THE LIFE-CYCLE DIVERSITY IN INSECTS.

V.A.Zaslavski (Zoological Institute, 199034, St.Petersburg, Russia).

Despite the phenomena concerned with the control of insect seasonality are extremely diverse, they could be covered in a unifying model. The main principles this was based on were as follows: quantitative daylength measurement; not joint but consecutive performance of the daylength measurement and the reaction type determination; processing of the photoperiodic information along two different pathways. Independent variation within a limited set of elementary characteristics was shown to produce a wide diversity of photoperiodic and temperature reactions. Physiological and genetic dissection of the life-cycle phenomena would be necessary to comprehend and manipulate the seasonal traits.

GREENBUG PECTINASES AND THEIR TOXICITY TO HOST PLANTS. Runlin Z. Ma (Department of Entomology, University of Illinois, Urbana, IL 61801, U.S.A.), William C. Black IV (Department of Environmental Health, Colorado State University, Et. Collins, CO 80523, U.S.A.), & John C. Reese (Department of Entomology, Kansas State University, Manhattan, KS 66506, U.S.A.)

Pectinesterase and polygalacturonase were detected in induced salivary secretions of the greenbugs, *Schizaphis graminum* (Rondani). The method involved construction of agarose-pectin gel plate on which the aphids were allowed to feed through parafilm, followed by ruthenium red staining of the gel to detect specific enzyme activities. A polygalacturonase was purified by affinity chromatography from biotype E greenbugs. The purified enzyme has a molecular weight of 45,000 Dalton, isoelectric point (pI) of higher than 9.3, optimum reaction pH of 5.6-5.9, and Michaelis constant (K_M) of 0.31 mg/ml using citrus pectin. The enzyme can be activated by Na^+, K^+, and NH_4^+, but inhibited by Ca^{++} at concentrations higher than 5 mM. The enzyme activity can be restored following SDS-PAGE by washing SDS off with Triton x-100.

The responses of the sorghum NC+150 to three pectinases were assayed. Micro-injection of the pectinases into the NC+150 leaves caused significant decrease in chlorophyll content at the treated areas. Some pectic fragments from sorghum and citrus pectin demonstrated similar effects when applied on the leaf surface. The results suggest that pectinases and pectic fragments are at least partially responsible for the damage when greenbugs feed on their host plants.

PECTINASES, CELL WALL FRAGMENTS, AND BIOTYPE EVOLUTION. John C. Reese, Runlin Z. Ma, and William C. Black IV. Department of Entomology, Kansas State University, Manhattan, KS 66506, USA.

Greenbugs (*Schizaphis graminum* (Rondani)) injected polygalacturonase (PG) and pectin esterase (PE) when allowed to feed on an agarose gel laced with pectin. Greenbug PG has been isolated, purified and partially characterized. These pectinases elicited distinctive responses, including a reduction in chlorophyll content, when injected into sorghum plants; similar responses were elicited by cell wall fragments produced by incubating sorghum pectin with greenbug pectinases. Differences in specific plant pectins and insect pectinases may explain some of the observable differences among biotypes of aphid species.

THE RELATIONSHIPS BETWEEN APHIDS AND THEIR HOSTPLANTS BASED ON CHINESE PEMPHIGIDAE, DREPANOSIPHIDAE AND LACHNIDAE (HOMOPTERA: APHIDOIDEA). Guang-xue Zhang, Wan-yu Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

A total of 293 species and subspecies under 81 genera of aphids belonging to Pemphigidae, Drepanosiphidae and Lachnidae have been recorded from China. The relationships between fauna of aphids and their flora of hostplants have been analysed. According to the Chinese data, the Chinese aphid species makes up 24.2% of the total world species,which coincides with the Chinese plant genera making up 24.5% of the total world genera.The number of Chinese aphid genera makes up 55% of the total genera of the world, which is basically coincidence with the Chinese plant families accounting for 56.9% of the ones in the world.

Comparsions of aphid specificities can be concluded that the aphid species are associated with the genera taxon of host-plants and the aphid genera are associated with the corresponding families of host-plants.

PRINCIPLES OF RESISTANCE OR ACCEPTABILITY OF PLANTS TO APHIDS. W.F. Tjallingii (Dept. Entomology, Agricultural University, Binnenhaven 7, 6709 PD Wageningen, The Netherlands).

Aphids spend a considerable time probing and walking on their own host plant before reaching a phase of sustained sieve element ingestion. An average period of 2-5 Hr is no exception. During a probe however, i.e. a period of stylet penetration, the sieve elements can be reached within 10-20 min. Why then, do aphids need all this time and why they are so critical after reaching of a sieve element of even their own host plant?
Many different principles have been suggested to form the basis of host plant selection and often the principles known from chewing insect has been used as a model. A number of these principles and the comparability of aphids with chewing insects and the in respect to food plant selection will be discussed in view of recent results obtained by transmission electron microscopy (TEM) and the electrical penetration graph (EPG) technique.

THE CHEMICAL BASIS OF HOST PLANT RESISTANCE TO APHIDS IN LETTUCE.

Maarten van Helden, Wageningen agricultural university, Binnenhaven 7, 6709 PD Wageningen, The Netherlands.

The monogenic absolute resistance of lettuce (*Lactuca sativa*) to the aphid *Nasonovia ribisnigri* was studied using Direct Current Electrical Penetration Graphs (DC-EPG), behavioral observations and chemical analysis. Near isogenic resistant and susceptible lines were compared. Behavioral observations and EPG's showed that the resistance is located in the phloem of the plant.

DOMINANT FACTORS IN GALL-APHID - HOST TREE INTERACTION: TREE CHEMISTRY, TREE PHENOLOGY, OR CHANCE? David Wool and Moshe Burstein, Department of Zoology, Tel Aviv University, Tel Aviv 69978, Israel.

Gall-forming aphids are host specific and must have very close interactions with the primary host to induce gall formation. Fifteen species of Fordinae (Pemphigidae, Aphidoidea) colonize Pistacia trees in Israel. Extreme differences in gall densities are consistently observed between different trees. These can be due to (1) host-tree preference by sexuparae, (2) differences in tree chemistry affecting the performance of fundatrices, (3) differences in tree phenology, which determine its suitability for colonization at critical times (by either sexuparae or fundatrices), or (4) chance. Long-term studies of three species rule out (4) and suggest that (1) and (2) play minor roles. Tree phenology (3), which is affected by environmental variables, seems to be a decisive determinant of gall density.

STUDIES ON SCAPTOMYZA FLAVA A LEAF-MINER OF BRASSICAS. *Ali A. Seraj Ph D student, Department of plant health, Massey University, Palmerston North. New Zealand.*

Scaptomyza flava (Diptera. Drosophilidae) is a native leaf-miner and occurs throughout New Zealand.

When the S. flava, was held in the laboratory, an average of 130 eggs were laid. Adult longevity averaged 3 weeks, and the sex ratio was 1:1 or a slight bias in favor of males. Total time required for development was 4 weeks at 20 C°. The majority of adults mate soon after emergence. Protracted copulation takes 20 min-1 hr. Male and females mate more than once. Under greenhouse and laboratory conditions most females begin oviposition within 36-48 hr after emergence. Females generally lay the majority of eggs between days 7-18 of adult life.

S. flava females produced an average of 130 eggs when offered honey solution , 100 when offered yeast , 140 when offered mix of honey and yeast and 89 when offered water only.

Longevity depends on access to food S. flava females lived 20 days with access to honey solution (without host plant) , 10 days with water only and 2 days on glass plates (starved).

ORIENTATION OF THE CARABID BEETLE AGONUM DORSALE IN AUTUMN. K. Abildgaard, M. Pedersen, L.T. Pedersen, (Inst. of Zoology & Zoophysiology, University of Aarhus, DK-8000 Aarhus, Denmark) and N. Elmegaard (Nat. Environmental Research Institute, P.O.Box 314, DK-8600 Silkeborg, Denmark)

The carabid beetle Agonum dorsale Pont. is common in arable fields in Denmark, but overwinters outside the fields in uncultivated habitats eg. hedges. In autumn it was studied how A. dorsale locates overwintering sites. Marked beetles were released in the center of fenced arenas (Ø=12m) placed 12.5, 25 and 50 meters from a hedge. The beetles were recaptured in pitfall traps placed along the inside of the fences and data were analyzed by means of circular statistics. The experiments demonstrated that A. dorsale use visual stimuli when searching for overwintering sites and it can recognize silhouettes forming an elevation angle of 10 degrees to the horizon. When no silhouettes are visible the beetles performed a non random movement with a mean direction towards North-West. Close to the hedge the beetles were guided by other stimuli.

THE ECOLOGY OF THE STAPHYLINIDAE IN THE FORESTS OF WEST SIBERIA. A.S.Babenko (Biology & Biophysics Research Institute, Tomsk 634010, USSR)

The reseache was conducted in the forests of different types of West Siberian region. There are about 450 species of Staphylinides in all forests habitats at large. Most of this closely connected with forests litter. There are 65 species in all type of pine forests; 56 and 48 species in cedar and silver fir forests respectively. Most of the rove beetles have high activity during from May to October in the south part of West Siberia. All rove beetles are inactive in winter during period of snow cover.

THE EXCRETION OF HONEYDEW BY GREENHOUSE WHITEFLY TRIALEURODES VAPORARIORUM Westwood. Hong Lei, Rumei Xu, (Biology Department, Beijing Normal University, Beijing 100875, China)

The amount of honeydew excreted by sap-sucking insect can be regarded as an index of direct and indirect impairment to host plant. I. Age effect. The order of AHS (area of honeydew spot) is: female adults, male adults, 4th instar, 3rd instar and 1st-2nd instar larvae. The result implies that adults are most responsible for the impairment to host plant. II. Temperature effect. The relation between AHS of 1st-2nd instar larvae and temperature is not significant, the AHS of adults and other instar larvae reach the maximum at 25℃. "Honeydew panting", which happened at 35℃ in adults is the result of rapid movement of abdomen in a state of hurry respiration. III.Rhythm of honeydew excretion. The adults excret the largest amount of hondydew at about 10 o'clock a. m. and the smallest at about 3 o'clock p. m. An adult may spend 20 to 22 hrs. a day on feeding and secreting, the 3rd or 4th instar larvae may keep feeding throughout 24 hr.without interruption. The frequency of honeydew excretion of adults is higher than that of the 3rd or 4th instar larvae. IV. Composition of honeydew. Amino acids and inorganic ions are included in honeydew besides carbohydrates. Glu, Thr, Asp and Val are of higher concentration among the 18 kinds of amino acids and K, Na, Mg, S, and P are the main elements among 15 kinds of inorganic ions. The dominant kinds and concentration of amino acids in whiteflies' honeydew are quite different from that in aphids'. This result demonstrates that the composition of honeydew are greatly related to the feeding insect.

LIFE HISTORY VARIATION IN DOLICHOPODA CAVE CRICKETS. Di Russo C., G. Carchini & V. Sbordoni (Dept. of Biology, "Tor Vergata" University, via O. Raimondo I-00173, Rome, Italy)

Life history tactics of Dolichopoda cave crickets are reviewed and compared with other known cave crickets. Life cycle duration, embrionic and larval developmental times, age phenology, egg size and fecundity are discussed to clarify the relationships between life cycle variation - within and among species - and environmental and historical factors.

CROWDING EFFECTS AND DIAPAUSE OF LOCUSTA MIGRATORIA IN JAPAN. Hiroshi TANAKA (Osaka Prefectural Agricultural and Forestry Research Center, Habikino, Osaka 583, Japan)

Locusta migratoria is distributed throughout Japan, though its outbreaks rarely occurred. Experiments in laboratory and field elucidated that Locusta in Japan showed clear crowding effects, e.g. coloration, F/C & E/F ratios, sexual dimorphism, adult longevity, fecundity, and percentage diapause eggs, as well as in Africa, Europe, China, etc.

Experiments were carried out on diapause induction and termination. The female collected in Hokkaido and the Northern Honshu laid diapause eggs both in short and long daylengths. The female from Kyushu, Shikoku and the Southern Honshu laid diapause and non-diapause eggs in short and long daylengths respectively. In the Loochoo Islands, the female laid non-diapause eggs both in short and long daylengths, though a few females laid diapause eggs in short daylengths. The embryonic diapause was terminated by chilling under 15℃.

Locusta in China was reported to have no embryonic diapause. The difference of diapause characteristics between Chinese and Japanese races may be explained by the frequency of outbreaks and migrations.

STRESS EFFECTS ON THE DIVERSITY OF DYSCERCUS FASCIATRS SIGN . IN THE LABORATORY CULTURES. S.H. Hodjat (Dept. of Plant Protection, College of Agriculture, University of Shahid Chamran (Ajwaz),Iran)

My Ph. D. thesis in 1963 at the Imperial Colle ge, London, compares various effects of crowding and sublethal doses of insecticides on laboratory cultures of D.fasciatus Sign.(Hem; Pyrrhocoridae). Unmated females lived an average of 41 days and produced 463.3 infertile eggs (11.3 eggs per day). Mated females lived 28.0 days and produced 506.5 fertile eggs (28.0 eggs per day). Stress (starvation, crowding, sublethal doses of insecticides) reduced their reproduction. Crowding 14 individuals per cage reduced the male and female size from 15.8 and 18.9 mm to 13.5 and 16.0 mm respectively.

D. fasciatus is not active and cannot fly in the laboratory but is very active and migratory in the field. Stress produced fluttering in both sexes and flight response in males. The average response to flight after ten times free falls was measured. The average flight response increased until the 5th day of males life and then decreased. In the 5th day the mean response was 2.8, 7.7, 5.6 & 4.3 at 1,2,4, & 8 males per cage. The control and 0.02, 0.04 & 0.08 Dieldrin produced 19, 12, 24 & 59 flight responses. Boiled cotton seed and partial starvation dietas also produced small individuals similar to those kept in crowded conditions.

PRELIMINARY STUDIES ON THE ECOTYPES OF ASIAN CORN BORER OSTRINIA FURNACALIS (GUENÉE) IN NORTHERN CHINA. Jian-ping Li, Wei-min Xie, Gui-hua Yang and Yun-sheng Wang (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Gongzhuling 136100, China)

Temperature and photoperiod effects on development and diapause were studied for six Asian corn borer populations from northern China. The test was conducted in the laboratory from 1989 to 1991. The results showed that Asian corn borer had three distinct ecotypes in northern China: first one represented by the Yuncheng and Xiongyue populations; second one represented by the Baicheng population; third one represented by the Dunhua and Keshan populations. The ecotypes differed in critical photoperiod for diapause induction, the sensitivity of larvae to temperature and photoperiod, the period of pupae and the period of larvae. The periods of pupae and larvae were shorter for first and second ecotypes than third one. The critical photoperiod for diapause induction was shorter for first ecotype than third one, while second ecotypes was intermediate. First ecotype was sensitive to photoperiod, but second and third ecotypes were sensitive to temperature. F_1 progeny from mating of first and third ecotypes showed that the inheritance was probably governed by a multigenetic makeup.

ECOLOGIC-MORPHOLOGICAL ANALYSIS OF THE CAUCASIAN ACARIDAE (ACARIFORMES). G.Sh. Kadjaia (Tbilisi State University, Tabilisi, Republic of Georgia)

About sixty of the family Acaridae mites have up to date been identified in the Caucasus. The specific composition and ecological pecularities of individual species have been found to show interzonal differences. Their habitats may be subdivided into two groups -constant and temporary. The widely-distributed species are characterized by zonal change of stations, as well as change of ecological diapason.

The seasonal variability of the morphological traits of different species and different populations of the same species differs from generations of warmer season are usually characterized by greater dimensions of morphological details in comparison with those of the cooler season.

Differences between colonies of the same population often exceed the differences between individual populations. Semi-desert and steppe populations are characterized by the smallest morphological details. They are followed by the subalpine zone populations and those of mountain forests. The population of subtropic forests are larger than those of others. The interzonal morphological differences are quite stable.

FLIGHT BEHAVIOUR OF THE POPLAR CLEARWING MOTH, PARANTHRENE TABANIFORMIS. Leen G. Moraal (Institute for Forestry and Nature Research, P.O. Box 23, 6700 AA Wageningen, The Netherlands).

Larvae of the poplar clearwing moth, Paranthrene tabaniformis Rott. (Lepidoptera: Sesiidae) bore into the stems of young poplar which may subsequently snap off. The sex-attractant, [(E.Z.)-3,13- octadecadien-1-ol], was used to study the occurrence, the seasonal and diurnal activities of this moth. The catches correlated positively with maximum and mean daily temperatures. Diurnal flight was peaking between 15.00-17.00 h. High densities of P. tabaniformis can occur in older poplar stands, from which the moths migrate to adjacent areas of newly planted poplars and may then infest the young trees.

Spatial flight pattern was studied in 12-year-old poplar stands. Traps were attached to the stems at 4 different heights (1.5, 4.5, 7.0 and 10.5 m) on trees about 15 m tall, with the help of a telescopic rod of the sort used to measure tree height. Significant differences in catches occurred: the higher the traps, the more males were captured. Traps were attached at intervals to the telescopic rod itself from 1.5 m up to a height of 13.5 m. The rod was erected in a newly planted poplar stand adjacent to an older poplar stand, at distances of 40 m and 80 m from the latter. Most males were caught at heights up to 3.5 m, following the contours of the young trees and the vegetation.

To test whether the yellow wasp-like abdominal stripes on the moth (which may have a mimicry function) are important for the male's orientation over short distances, experiments were done with dummy females. The males overlooked in many cases the dummies and tried to copulate with the pheromoon dispencers.

POPULATION DYNAMICS OF PARAVESPULID SOCIAL WASPS (HYMENOPTERA; VESPINAE) IN ENGLAND WITH SPECIAL REFERENCE TO INTRASPECIFIC USURPATION. M. E. Archer (Department of Biology, University College of Ripon and York St. John, YORK Y03 7EX, England, U. K.)

Populations of *Paravespula vulgaris* (L.) and *P. germanic*a (Fab.) can show a strongly pronounced 2-year cycle of summer wasp abundance which damps to equilibrium, driven by an endogenous mechanism. The equilibrium can be perturbed by an exogenous mechanism which is probably a function of summer and autumn weather. In 1981 it was proposed that the endogenous mechanism was probably driven by either a density-related intraspecific usurpation for early nests by spring queens and/or a density-related variation in queen quality. The above hypothesis will be re-evaluated from continuations of data sets based on Malaise and suction trap catches besides a new run of data based on nest counts of *P. vulgaris* from Wisley in Surrey, England. The importance of intraspecific usurpation and variation in queen quality will be further assessed in terms of new information from studies of vespine social wasps and other social insects of the genera *Polistes* and *Bombus*. The role of intraspecific usurpation requires a re-examination of the life history strategies shown by vespine social wasps.

PHOTOPERIODIC RESPONSES IN RELATION TO VARIABLE VOLTINISM IN THE RICE STEM MAGGOT, Chlorops oryzae. Mitsuyoshi Takeda (Tohoku National Agricultural Experiment Station, Omagari, Akita 014-01, Japan)

The rice stem maggot is bivoltine in northern Japan but trivoltine in the southern part of the country, and there is a transitional area where the two strains are distributed. In the maggot, both the egg and larval stages were found to be sensitive to photoperiod. When the egg stage was exposed a long-day photoperiod (15L:9D), larval development of the bivoltine strain showed a short-day type response but of the trivoltine strain showed a reversed intermediate type response indicating that their development was retarded under 14L:10D photoperiod but not under either shorter or longer photoperiods. When the eggs experienced short days, the first-instar larvae entered a diapause under short-day conditions. The critical photoperiod for the induction of the diapause was about 13hr in the bivoltine strain and 12hr in the trivoltine one. The results of crossing between the bivoltine and trivoltine strains indicated sex-linked inheritance controlled by a single nondominant gene concerning larval development and induction of diapause. In strains from transitional area, larval development was dimorphic, and their development was similar to that of F2 hybrids produced by reciprocal crossing between the two strains.

INVESTIGATION ON THE BIOLOGY OF *UVAROVISTIA ZEBRA* UV. (TETTIGONIDAE-DECTICINAE). P. A. Fard (Entomology Dept. Faculty of Agriculture, Karaj, 31584-IRAN)

This species has wide distribution in Iran, it lives sympatric with polysarchus elbursianus UV. and is collected mostly from nesa and Gachsar with elevation of more than 2500m. It causes economic injury on pasture, cultivated plants and fruit trees such as cherry in certain areas that necessitate chemical control. Under natural conditions, the first instar larvae could seen at late of March up to Mid April under Astragalus, Acantolimon and Artemisia plants in observed areas. Laboratory studies was carried out under controlled conditions. Mean nymphal periods in five instars were 6.8±0/75-6/8±0/97 8/4±0/8-8/2±1/16 and 7/8±17 respectively and the mean total nymphal periods was about 38±2 days, average longevity of adult for male and female were 28/75±8/87 and 33/16±4/06 respectively. Eggs are grayish, rice shaped with 5/5-6mm long and 1/5-2mm diameter, they are laid separately in 8 to 20mm depth in soil and they are attached together with a silky foam. This insect has one generation per year and over winters as eggs in the soil.

SOME INVESTIGATION ON THE ECOLOGY OF THE CODLING MOTH, LASPEYRESIA POMONELLA L. IN IRAN. Saeb, H. (Plant Pest and Diseases Research Institute of Gilan, P.O. Box 133, Anzali, Iran)

The ecology of the codling moth, *Laspeyresia pomonella* (L.), particularly seasonal distribution and abundance of the male by sticky synthetic sex pheromone trap, and with the help of corrugated paper bands was studied in apples, walnuts and pears orchard of Iskolak Rasht (Northern part of Iran) during 1987-1989. The insect has three generations of moth flight per year. The first male moth was caught in the sex pheromone trap in-mid April, when sum of degree-days was about 100°C.The flight of first, second and third generation moths were finished about mid June, late July and second half of September respectively, when sum of degree-days were 650, 1500 and 2200°C. The larvae began to diapause about June 15, and all larvae entered to diapause in the early September. The diapause amount of codling moth for generation 1-3 has been 3, 12 and 100%. The sex ratio of codling moth adults (male: female)in 1988-1989 has been 1:1.1 and 1:1.1 respectively.

LUCERNE WEEVIL (HYPERA VARIABILIS HERBST): BIOLOGY AND SEASONAL HISTORY. M.P. Gupta, V.J. Shivankar (Seed Technology Division), Indian Grassland & Fodder Research Institute, Jhansi-284 003, U.P., India).

A feemale weevil laid 600-1300 eggs in a period of 50-60 days inside the ovipositional cavity in the stems either singly or in clusters and died. Incubation lasted for 6-14 days and the young grubs fed in the opening leaf buds. The later stages wriggle down and fed on lower leaves. The larvae passed through 4 instars with 10-19 days larval period including a prepual period of 2-3 days Pupation occurred either on leaves or on soil for 4-14 days. Total life cycle completed in 20-47 days having only one generation in a year. The freshly emerged adults under-went diapause in the soil cracks during April. The diapaused weevils began to emerge from December, they fed on leaves and mate frequently. The grubs attained peak of their activity during February. Ovipositional preference is suggested to be the possible mechanism for plant resistance to lucerne weevil. Temperatures ranged from 8.8-17.9°C min. and 22.5-34.0°C max. with 41.3-78.0% R.H. during January to April.

EFFECT OF PIX TREATING COTTON TO THE OCCURRENCE OF BOLLWORM (Helothis armigera Hubner) Yong-Xiao Zhang, Chi-Yang Cao, Shu-Hua Wu, Yang Zhao (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences, Nanjing 210014, China) Zhi-Gang Zhao, Xue-Ying Hu (Station of Plant Protection, Siyang County)

In laboratory test the cotton plants treated with 100 ppm of Pix will receive 44.7-60.3% less eggs of bollworm than the normal plants. Field investigation indicated that the eggs of bollworm reduced 48.8%, 62.8% and 76.7% on the plants treated with Pix 7.5, 15 and 30 ai g/ha respectively. The body weight of bollworm larvae and pupa developed from the larvae feeding on the Pix treated topical leaves and squares decreases 16.2 and 14.8%. The mortality of larvae on the treated plants increased 42.8% and the rates of pupation and moth emergency reduced 29.3% and 7.1%. The gossypol content in treated plants increased 33.3-55.5% in leaves 37.8-63.5% in squares and 21.5-47.5% in yong bolls as comparing with normal plants. The maximum contents of gossypol were shown at the twelfth day after treatment in leaves and squares and ninth day in young bolls. The RGR (relative growth rate) and AD (approximate digestibility) of larvae reduced 16-20% and 13.4-16.2% feeding on leaves and squares respectively. The reduction of RGR and AD was considered due to the increatment of gossypol in the leaves and squares.

THE REPLACEMENT OF THE EUROPEAN EARWIG (Forficula auricularia) IN THE EARLY OF FREE FORAGING PHASE. Syamsudin Tati S., M. Jarry (IBEAS Universite de Pau, Campus Universitaire, 64000 Pau France)., S. Sastrodihardjo (Inter University Center-Life Science ITB, Ganesha 10 Bandung 40132 Indonesia).

The deplacement of the European earwig in the early of the free foraging phase were estimated using two approach : horizontal and vertical trapping. Observation founded that during this period, captures were dominated by third larvae instar. Horizontal trapping above the ground showed that the horizontal movement towards the tree was irregular. Spatial index of autocorrelation indicated that earwigs chose certain place. The distributions per trap was very aggregative and the dispersion index was very important. Different results of the capture between two bands showed different flux of activity in the tree trunc. The number of individue captured in the upper bands was higher than lower bands, which indicated the existance of the vertical movement during this period.

A PRELIMINARY STUDY ON EFFECTS OF TEMPERATURE AND HUMIDITY UPON SURVIVAL AND FECUNDITY OF THE ASINA CORN BORER, OSTRINIA FURNACALIS (GUENEE). Zhong-yue Wang, Da-rong Zhou (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Effects of temperature and humidity on different developmental stages of the Asian corn borer, Ostrinia furnacalis (Guenée), were studied. The influences on hatching, pupation and emergence rates were observed, with an emphasis on the subsequent fecundity of the females. The regression equation on such influences were established. Thirty combinations of temperature (ranging from 15 to 40°C, with a 5-degree interval) and R.H. (ranging from 20 to 100%, with a 20% intermal) were used. The main results can be summarized as: for eggs, when temperature was kept constant at a certain level, the hatching rate increased with the increase of R.H.; for full-grown larvae, either high (over 80% R.H.) or low (under 40% R.H.) was proved to be not only unfavourable to pupation, but also to subsequent emergence and oviposition rate; for pupae, under a constant temperature from 15 to 30°C, the higher was the R.H., the higher would be the emergence and subsequent oviposition rate, however, if the temperature was over 35°C, higher R.H.(over 80%) turned out to be unfavorable; and for adults, under a constant temperature from 10 to 35°C, the fecundity increased with the increase of R.H., provided that it did not exceed 80%.

THE COMPARATIVE EFFECTIVENESS OF THE PHENOLOGICAL FORECASTING METHODS. E.D.Abashidze(Plant Protection Institute, 380062 Tbilisi,Republic of Georgia)

The treatment of the phenological forecasting of pests counts for much in the optimization protective measures. The comparative estimating of four forecasting methods-method of sum effective temperatures(SET), method of temperature-phenological nomogram (TPhN), forecasting method by air warmth content and regressive equations was carried. The model object was grape vine moth (Lobesia botrana)-one of the most dangerous pests in Georgia. It widely spread in vinegrowing regions of Georgia. In the result of comparative analysis of four forecasting methods relatively high exactness of the TPhN-method was established. This method demands use of the system of equations. The SET-method uses one equation that is not correct. Forecasting method by air warmth content is recommended if precipitation and high humidity will be expected.

THE PLAGUE MODELS OF FOREST PESTS AND DISEASES AND ITS SIMULATION. Guo-fa Zhou (Department of mathematics, The Branch Campus of Beijing University, Beijing 100000, China)

A simulation model was used to establish the plaguy level of forest pests and diseases, it consists of three parts: food model, distribution model of insects and plague forecast model. The plague model is different from the leaves lose rate model, it contains leaves quantities, insects quantities and the dispersal of insects. The least square method was used to estimate the parameters in all model, and the automatic calibration program was given in the paper. The model was applied to simulate the ptague of pine caterpillars. The simulation results are quite well, and the distribution of plaguy levels is the basis of integrate management of forest pests and diseases.

AN ANALYSIS OF PERIODIC PHENOMENON AND A LONGTERM PERIDICTION OF THE ORIENTAL ARMYWORM, MYTHIMNA SEPARATA WALKER. Bohai Hu (Station of Crop Pest Forecast, Ministry of Agriculture, Beijing 100026, China)

The computer apptied to anatysis, which is based on a number of years of outbreaking level of the overwintering generation, the first generation and the third generation of armyworm suggested that the long period is 16 year with 8-9 year serious outbreaks for the overwintering generation, 15-18 year with 6-7 year serious outbreaks for the first generation and 15 year with 8-9 year serious outbreakss for the third generation.

The result of longterm prediction over one year (1-5 year) is quite accurate. It has tested, verified and predicted for five years. The precise rate of testing and verifying is 77.3%. The accurate rate of prediction is 86.4%.

SEASONAL CHANGE OF ADULT POPULATION DENSITY OF MELON FLY DACUS CUCURBITAE (DIPTERA:TEPHRITIDAE) IN GUANGZHOU. Changqing Zhou, Haidong Chen (Research Institute of Entomology, Zhongshan University, Guangzhou, 510275,China)

This study was carried out with Steiner Trap and Lantern-type Trap, whech containing methyl eugenol and insecticide, in vegetable fields and fruit orchards from June, 1989 to September, 1991. Field investigation of damaged bitter melon was conducted every 10 days. The results showed that there were 2 peaks of population density of adult D. cucurbitae for a year in Guangzhou, the first occurred from mid-May to July, the second one occurred in the period of August to mid-November, the later was rather higher than the first one. Bitter melon was the host that most serious being damaged, under normal management condition 7% to 24% damage were observed, in some fields, where there were not any control, damage reached 64% or more. The population density peak concided with the harvest period of hosts. Base on the results the control strategies are discussed.

ECOLOGY AND CONTROL OF GALLERIA MELLONELLA L. IN TAIWAN. Chia- Pao Chang, Feng-Kuo Hsigh, Li-Zong Hau (Taiwan Apicultural and Sericuotural Experiment Station, 261 Kuan-Nan, Kung-Kuan, Mio-Li, Taiwan , China)

Galleria mellonella L. is one of the most important insect pests of apiary in Taiwan. Systematically, its frenulum is composed pf three and one spine for female and male, respectively. This pest was found all year around with overlapping generations. Female began to oviposit right after emergence. Its development was the shortest in the mid-summer. The newly hatched larvae penetrated into the comb and mature larvae pupated in the tunnel inside the the damaged comb. Larvae overwintered and pupated in the spring. The effective living temperature ranges, high and low lethal temperatures were determined to be 16℃ to 42℃, 44℃, and 6℃, respectively for the larvae. Adults were active at 15℃ to 41℃, and their high and low lethal temperatures were 46℃ and 5℃, respectively. The population peaks were from July to August and October to November. The population density was low in high altitude area and royal jelly-collecting colonies. Chemical efficacy test on this pest indicated that the phostoxin D. was extremely effective, however, it could also be controlled effectively when exposed to this pest -13 or -25℃ within 3 hrs.

STUDY ON THE POPULATION SYSTEMS OF MAIN INSECT PESTS OF PADDY FIELD IN SOUTH CHINA. Guang-wen Liang, Xiong-fei Pang. (Lab. of Insect Ecology, South China Agricultural University, Guangzhou, 510642, China)

Paddy borer, *Scirpophaga insertulas* (SI), brow planthopper, *Nilaparavata lugens*(NP) and rice leaffolder, *Cnaphalodrocis medinalis*(CM) are main pests injuring rice in South China. The present paper dealt with the population system structures, population prediction and control of the pests. The effectiveness of various ecological factors to the population dynamics of the pests were analysed by means of the index of population control. It showed that predators, such as spiders in paddy fields, and resistant varieties of rice were important factors effecting the population dynamics of the pests. By the action of natural enemies and moderate resistant varieties of rice, the populations of NP and CM could been maintained at levels below those causing economic injury. The population systems of the pests were simulated by state-space method,and reliability of these models come up 80% for population prediction.

SPATIAL DISTRIBUTION PATTERN OF ANT-LION UNDER DIFFERENT EXPERIMENTAL CONDITIONS. Han-hui Zhou, Xuan-da Zhang (Research Institute of Entomology, Zhongshan University, Guangzhou 510275, China), Jing-quan Jiang (Guangdong Entomological Institute, Guangzhou 510260, China)

An experiment was conducted to study the spatial distribution pattern of ant-lion larvae under different conditions. The results are as follows:

1. The spatial distribution pattern of ant-lion larvae was not influenced by the feeding interval of days. After a few days, the distribution trended to be stable.

2. The distribution frequency in each sample area showed that, the preferential space for one third-instar larvae of ant-lion was about 40 cm^2, and 30 cm^2 for one second-instar larvae.

3. There was an evident influence of the diameter of sands on ant-lion life, The diameter of sands in 40 mesh was the most beneficial for its life.

SPATIAL NICHE OF PREDATORS IN PADDY FIELD AND ANALYSIS OF PREDATION EFFECT. Jin-cai Wu(Department of Plant Protection of Jiangsu Agricultural College, Yangzhou 225001 , China)

Niche of a species is multidimension and hypervolum. Niche theory and its application are research project which has extensively been drawn attention in modern ecology. Especially , as a case of coexistence system of multispecies of natural enemy with multispecies of insect pest, control effect of natural enemy on the pests and their comprehensive evaluation are an important basic work of IPM. This paper investigated the numbers of predators and planthoppers on the base, stem and leaf of rice plant, and studied spatial niches of these species by means of niche width and niche overlap index. And then predation effect of the predators and relations among inter and intra—species under condition of 7 species coexistence(5 predators and 2pests) were analysied by application of orthogonal design and exclusive and additive methods. The results showed the order of niche width values was C. japonicola>P. fuscipes>O. insecticeps>P. subpiraticus>T. praedonia>B. hotingc hleh—i> C. lividipennis> T. octomaculatum, the niche overlap indices of C. japonicola, O. insecticeps and C. lividipennis with WBPH were greater than those with BPH, whereas the indices of P. subpiraticus and P. fuscipes with BPH were greater than those with WBPH. These coincided with the object(prey) preyed by the species.

SUPPRESSION OF THE POPULATION DENSITY OF STINK BUG, PIEZODORUS HYBNERI, BY EGG PARASITOIDS IN A SOYBEAN FIELD. Hiroya Higuchi (Kyushu National Agricultural Experiment Station, Nishigoshi, Kumamoto 861-11, Japan)

The stink bug, Piezodorus hybneri, is an important pest of soybeans in Kyushu. Egg parasitoid, Telenomus sp., is an efficient natural enemy of P. hybneri. The effect of Telenomus sp. on the population dynamics of P. hybneri was studied in a soybean field.

Adults of P. hybneri immigrated to the soybean field at the pod development stage of soybeans in the middle of July. Their oviposition started shortly after the immigration and lasted till harvest. Hatchiability of P. hybneri eggs was high only at early stages of oviposition and soon dropped to nearly zero levels, owing to parasitism by Telenomus sp. Afterwards high parasitism rates more than 80% was maintained.

The number of Telenomus sp. females caught by a suction sticky trap operated in the soybean field suddenly increased in the middle of July. This result indicated that soon after the immigration of P. hybneri into soybean field, females of Telenomus sp. also invaded the field to attack P. hybneri eggs.

Egg parasitism of Telenomus sp. was high enough to suppress P. hybneri density below the control threshold. Therefore there exists a possibility of successful biological control of P. hybneri using this parasitoid.

ECOLOGY AND FORECAST OF THE MOROCCAN LOCUST Dociostaurus maroccanus (THUNB.) IN THE USSR. A.V.Latchininsky (All-Union Research Institute for Plant Protection, VIZR, 3, Podbelsky Street, St.Petersburg - Poushkin, 189620, Russia).

The preferred habitats of the Moroccan Locust in the USSR occupy the uncultivated arid steppes and foothills with ephemeral vegetation up to 1.000 - 1.200 m of altitude in the Central Asia, Transcaucasus and Northern Caucasus. The Northern limit of its distribution coincides with the spring isohyet of 100 mm. In order to compose a long-term forecast of the Moroccan Locust, it is necessary to determine the phase and the trend of its population dynamics. We establish 4 such phases: recession, upsurge, outbreak and diminution, each of them can last from one to several years. They differ one from another by the following main characters: density of hoppers, adults and egg-pods, degree of gregarisation and morphometrics of adults. The scale of special indices for evaluation of the influence of agro-climatic factors on the development of locusts is invented. The trend of the population dynamics is determined by the comparison of the action of the above-mentionedecological factors during two or more years running. Practical application of the proposed method and the possibilities for its utilization in bio-modelling are discussed.

PERIODICAL OUTBREAKS IN SEVERAL CEREAL BUGS FEEDING ON WHEAT AND BARLEY (HETEROPTERA-PENTATOMOIDEA). M. Javahery (Department of Entomology & Lyman Entomological Museum, Macdonald College of McGill University, Ste. Anne de Bellevue, P.Q. Canada H9X 1C0)

Long term study of the seasonal abundace of several pentatomoid bugs feeding on wheat and barley cultivations indicate a periodical outbreak in the population of these insects. The selected bug species are Aelia furcula (F.), A. rostrata (Boh.), Eurygaster integriceps Put., and A. Maura (L.).

Changes in the seasonal abundance and population dynamics of these species were investigated in several regions of outbreak in relation to variouse known factors affecting the population(including cultivating methods and application of insecticides) during the past thirty years (1961-1991).

According to the above study a clear outbreak in the population of these bugs is recorded every 7-8 years. The results taken from this investigation provid very useful information about expected years of outbreaks. This will help in a more effective control and management of these economicaly important hemipterous pests of cereals.

CHLOROPHYLL FLUORESCENCE IN BARLEY INFESTED WITH APHIDS. L.R. Blanco, H.Y. Adamson and D.F. Hales (School of Biological Sciences, Macquarie University, N.S.W., 2109, Australia).

Chlorophyll fluorescence is an extremely sensitive indicator of deleterious effects of environmental stress on plants and has been used extensively in ecophysiological studies of the effect of habitat variables (light, temperature, nutrients and pollution) on plants of agricultural importance. This paper describes the use of chlorophyll induction kinetics to detect the onset of stress in aphid-infested plants. Two-leaf-stage barley plants (*Hordeum vulgare* cv. clipper) were infested with the aphid, *Sitobion* nr *fragariae*, and key fluorescence parameters (initial, F_o, variable, F_v and maximum, F_m) were measured at 0, 4, 7, 14 and 21 days after infestation on leaves of different ages. Small but significant stress effects, indicated by the reduction in the efficiency of light capture by photosystem II reaction centres (i.e. reduction in F_v/F_m) were observed not earlier than 4 but not later than 7 days of infestation. The significance of the finding in relation to the delayed onset of other stress symptoms (e.g. reduced photosynthetic capacity, chlorosis, after approximately 3 weeks) is discussed.

KEY FACTOR STUDIES OF *CTENARYTAINA THYSANURA* ON *BORONIA MEGASTIGMA* IN TASMANIA. R.K. Mensah and J.L. Madden (Department of Agricultural Science, University of Tasmania, GPO Box 252C, Hobart, Tasmania, Australia, 7001.)

The psyllid, *Ctenarytaina thysanura* Ferris & Klyver, is the most serious pest on *Boronia megastigma* Nees, and essential oil crop in Tasmania, causing about 41.7 percent loss of flowers and suppressing oil yield amounting to over 30 percent monetary loss to the growers.

The psyllid was studied intensively in Tasmania, Australia, for nine generations (1986-1989) and identification and quantification of different mortality factors determined by key factor analysis. The analysis revealed that mortalities in late (3rd-5th) nymphal stages of the psyllid were key factors influencing the *C. thysanura* population. Based on simple graphic analyses, the psyllid population density cycles were caused by delayed negative feedback processes due to the numerical response of the pest insect's natural enemies.

CHANGES IN POPULATION DENSITY OF HERBIVOROUS INSECTS IN AIR POLLUTION GRADIENTS. M.Kozlov, S.Neuvonen, E.Haukioja. (Lab. Ecological Zoology, University of Turku, SF 20500, Finland)

Industrial pollution can radically change population densities of insects. The following four patterns of *ecological* density (in relation to the food supply) along pollution gradients have been repeatedly reported: (i) density peaks at moderately polluted areas being low both near the source and further away from it, (ii) the peak is at the most polluted area; (iii) no trend in density, and (iv) maximum density in unpolluted areas. The last type seems to be rare.

Changes in density depend both on the background population density and on the strength and quality of the pollution source. When the background density is low, no significant changes are observed along any gradient of air pollution. If the background density exceed a species-specific "threshold" level, the type of change depend on the power of the source. The peak in insect density may be related to the same level of host-plant stress, but the distance from the source of emissions is different for different emission sources.

Since amount of available food per unit area often changes along pollution gradients, the *spatial* density (defined per unit area) may change in different ways, which do not necessarily correspond with changes in ecological density.

To summarize, the type of change in the population density is not a species-specific or a source-specific characteristic but the result of interactions between biotic and abiotic factors. There are no clear borderlines between the three types (i - iii) of changes: the same herbivorous insect may even show different types in different situations.

DAILY TIME BUDGETS AND ENERGETIC CONSEQUENCES FOR A NIGHT ACTIVE INSECT, THE TOBACCO HAWKMOTH *MANDUCA SEXTA*. R.D. Stevenson and Kathleen Corbo (Department of Biology, University of Massachusetts/Boston, Boston, MA 02125-3393, USA)

Behavioral observations were made on a laboratory colony of the adult sphingid, *Manduca sexta*. Animals were maintained on 16L:8D light-dark cycle in a room 1.8 x 1.8 x 2.2 m in dimensions. Dilute honey-water was provided as food in artificial flowers. Activity could be divided into 4 broad categories: resting, warming-up for flight, flying and copulation. "Young" animals (<5 days old) spent about 66% of the time resting and 8% copulating while "old" animals (≥ 5 days) rarely copulated (copulation = 0.7%, rest = 76%). On average animals spent about 20% (1.6 h) of the night flying and 4% (0.32 h) warming-up. "Young" moths were slower to become active during the night and activity (activity = flight + copulation) for this group peaked in the third hour after lights out while activity of older animals peaked during the first two hours. Males spent about twice as much time flying as did females. The amount of time a female spent in flight was directly correlated with the number of eggs she laid. Because the metabolic rate of flight about 170 times greater than during rest, on average flight activity accounted for about 90% of the total daily energy requirements. To maintain body mass a 1.5 g moth must drink about 1.4 g of 20% (by mass) sugar solution per day. Animals which learned to feed increased their life span from 4-6 days to 14-28 days.

ON THE POPULATION DYNAMICS AND AGGREGATION BEHAVIOR OF MIGRATING COCCINELLA SEPTEMPUNCTATA LINNAEUS IN THE SEASIDE OF QINHUANGDAO PENINSULA. Xiao-ming Cai, Yu-chang Shang (Department of Biology, Beijing University, Beijing 1000871,China),Jun-jie Yan (Department of Economic Forest, Hebei Forestry College, Baoding City Hebei Province, China)

In this paper, the fifteen year investigation on the behavior of Coccinella septempunctata Linnaeus carried out by the Central Observation Station, since the first discovery of migrating C. septempunctata in June 1976 in the seaside of Qinhuangdao Peninsula, were reported. In this area, the migrating population occurs during middle May to early June, with the occurrence peak in early June, as the migrating female is in the teneral period of preovipositional stage. Five successive period of its aggregation procedure in this area were described.

SIMULATION OF THE NATURAL POPULATION DYNAMICS OF THE CITRUS RED MITE, PANONYCHUS CITRI (McGREGOR). Yibin He, Mingdu Huang, Honghe Wu, Jingye Zhang (Guangdong Entomological institute, Guangzhou, 510260, China)

This paper deals with the simulation of natural population of citrus red mite (Panonychus citri). The main results are as follows:

1. Submodels for development and production

The relationship between development rate and temperature were established for eggs, larvae, nymphs and adults of citrus red mite.

2. Submodels for survival rate

A new method for estimating the time-specific survival rate of each stage of insects with overlapping generations was developed. This method could be applied to any populations without a stable age (instar) distribution, and theoretically it could be applied to any populations with over-lapping generations. The relationship between survival rate and temperature, rain, natural enemies, and other ecological factors were established for eggs, larvae, nymphs and adult females on both new and old leaves.

3. Simulation of population dynamics

Based on the established submodels, simulation of the population dynamics of citrus red mite was carried out by using the dimension-changeable matrix model (Xu Rumei et al. 1981). The simulated results could be approached by the observed results satisfactorily.

ANALYSIS OF LIFE TABLE PARAMETER BASED ON PHYSIOLOGICAL TIME SCALE OF RHOPALOSIPHUM NYMPHAEAE. Zhi-qiang Lu, Zhi-yi Dei, Jian Zhu (Jiangsu Agrecultural College,Yangzhe 225001,China)

The relationship between temperature and nymphal developmental rate for R. nymphaeae was studied in the laboratory. The study gave estimates of lower (11.24 °C) threshold for development, and the thermal sum of 16.49 day-degrees, which provided basis of dividing physiological time scale for analysis of life table parameter.

Age-specific life table parameters were estimated for laboratory apterous population under 20, 24,28 and 32°C. The population growth statistics varied with the temperature,but converged when the physiological time scale(IP) was used.The fecundity(l_x)and survirorship(m_x)patterns for three apterous population under 20,24,28°C temperature were similar,and the statistics (such as r_m) were tending towards stability.

The stable stage distribution for apterous population under different adaptble temperature was same, but varied with the population on different host plants.

SPATIAL AND TEMPORAL PATTERNS OF PARASITISM IN A HOST-PARASITOID INTERACTION. T.H. Jones and M.P. Hassell, Department of Biology and NERC Centre for Population Biology, Imperial College, Silwood Park, Ascot, Berks. SL5 7PY UK.

Using data collected over a period of nine years this study investigates the relative contributions to the dynamics of the host of both spatial and temporal patterns of mortality caused by generalist and specialist parasitoid species. The system chosen to study is that of the cabbage root fly, Delia radicum (Diptera: Anthomyiidae) and its two most common parasitoids, Trybliographa rapae (Hymenoptera: Cynipidae) and Aleochara bilineata (Coleoptera: Staphylinidae). Modern methods of analysis are used to illustrate how parameterised models of natural host-parasitoid interactions can be applied directly to field data, and then used to explore a number of dynamical possibilities.

ON THE CHILO SUPPRESSALIS DAMADGE MODELLING. Bin Chen, Weiwen Wu (Dept. of Plant Protection, Southwest Agricultrual University, Chongqing 630716, China)

A series of experiments basing on five experiment factors-egg and transplanting density, egg-setting leaf age; nitrogenous and phosphate fertilizer, and systematic investigations of quantities of total, dead heart and dead sheath rice plants from May 30th to June 29th were carried out at Chongqing in 1987-1989. Some mathematical models on the relationships between all experiment factors and yield, and between quantities of total, dead heart and dead sheath rice plants during different rice growth periods and yield loss were established. The development trends of total, dead heart and dead sheath rice plants and the optimum levels of all experiment factors were detailedly discussed. The results showed that from 9-to 15- leaf age only when the ratio of dead heart plants reached or excessed 8%, 20%, 20%, 4%. 4%, 1% and 1%, respectively, effective ears per unit area markedly decreased, and only when the ratio reached or excessed 8%, 20%, 20%, 12%. 8%, 4% and 1%, respectively, yield per unit area notablely reduced. From 12- to 14- leaf age, occurrence of dead heart in 1% or 2% of plants helped raise the yield.

MATHEMATICAL MODEL OF RELATIONSHIP BETWEEN THE ATTACK ON THE PUPAE OF LEPIDOPTERAN PESTS BY HYMENOPTEROUS PARASITES. Bui Tuan Viet (Institute of Ecology and Biological Resources, National Centre for Scientific Research of Vietnam, Nghia Do, Tu Liem, Hanoi, Vietnam)

In the laboratory observed that, Phaeogenes sp1, P. sp2, Xanthopimla flavolineata Cam. no attack on the lepidopteran pupae of 5 days or more, the attack on the host's pupae of 2 days (31%), after that of 1,3,4 days and prepupae (25%, 22.2%, 19.2% and 2.7%).

It elicit model, in which the attack on the host's pupae by parasites limited in the host's pupal suitable instars for parasites. So that the relationship between the attack on the pupae of lepidopteran pests by hymenopterous parasites described by the following mathematical model:

$N_{n+1} = (N-q) \exp [(-N_{an})/(N_n-q)] + q;$

$N_{an+1} = (Nn-q) \{1-\exp [(-N_{an})/(N_n-q)]\};$

Where:

N_{n+1} - number of host's pupae in the new generation.

N_{an+1} - number of parasitical pupal host in the new generation.

q - number of host's pupae no attack.

n - number of generation.

THE DECOMPOSITION TECHNIQUE OF LARGE SCALE PEST SYSTEM IN RICE FIELD. Fang-ling Tao, Guang-wen Liang, Xiong-fei Pang (Lab. of Insect Ecology, South China Agricultural University, Guangzhou, 510642. China)

In present paper, the decomposition technique of the large scale pest system in rice field is studied by the selective ratios of the wolf spider, *Pirata subpiraticus*(PS) on the white back planthopper, *Sogatella furcifera*(SF)and the leaf roller moth, *Cnaphalocrocis medinalis*(CN). The quadratic function model describing the relationship between the number of prey attacked and the densities of predator and its preys is constructed. The parameters in the model are identified by the rotation composite design of quadratic regression on the average values of three tests. Based on the models of CN and SF, the selective preying ratios are calculated for the decomposition of the large scale pest system in rice field. Therefore, the input U(t) of PS to the large scale pest system can been expressed by the following vector,

$$U(t) = \begin{vmatrix} u_1(t) \\ u_2(t) \end{vmatrix} = \begin{vmatrix} Q_1(N_1,N_2,N_3)\ P(t) \\ Q_2(N_1,N_2,N_3)\ P(t) \end{vmatrix}$$

where $u_1(t)$ and $u_2(t)$ are the parts of the vector U(t), $Q_1(N_1,N_2,N_3)$ and $Q_2(N_1,N_2,N_3)$ are the selective preying ratios of PS on SF and CN, P(t) is the density of PS at time t.

THE SPATIAL-TEMPOTAL DISPERAL MODELS OF INSECT POPULATIONS AND ITS SIMULATION. Guofa Zhou. (Department of Mathematics. Branch Compus of Beijing University. Beijing 100083. China)

A population dynamics model incorporating age-. size-and spatio-temporal autocorrelation is proposed. which is based the focus charactors of the, occuring of disease and insect pest and the spatio-temporal tendency of the epidemic; it is a development form of the age-size population model. The discrete form of the model is:

$$U_{ij}^{t+\Delta t} = \sum_{a=1}^{P} \sum_{s=1}^{g} A_{ia} U_{sa}^{t} X_{sj} + \sum_{s=0}^{g} \sum_{k=0}^{j} \beta_{sk} L^{s} U_{i-k,j}^{t}$$

It contains the age-. size-specific and spatio-temporal autocorrelation of the population. To similate the population dynamics. through the survivorships of mortality of all ages and spatio-trmporal autocorrelation. the distribution of population number in space is sequentially updated by teh size. age and diffusion operator. this is the basis of the pest management. The size operator has not previously been defined. thereas the age operator can be recognized as the subdiagonal survivorship elements of the Lewis-Leslie matrix. Birth is incorporated by defining birth size matrix. Spread of the pine moth is used as the simulation example.

THE VERIFICATION OF MATHEMATICAL MODEL FOR INSECTICIDE RESISTANCE MANAGEMENT. Jian-mei Yang, Song-gang Li, Ling-yuan Li(Department of Biology, Peking University, Beijing 100871, China)

Upon the basis of "The Mathematical Model for Insecticide Resistance Management", a series of simulated experiments for adult houseflies collected from Beijing had been achieved. The different colonies were established by exposing in different insecticides (7504, Propoxur /or the mixture of them) for successive twelve generations. The level of resistance can be predicted on the comparison with affinities of AChE to substrate (Km value, Vmax) in different colonies in order to make sure which management strategy can be accepted and extended. The results showed that: (1) The specific activities of AChE, MFO and Km value etc. in colonies which had contacted Propoxur and by using the "checker board" method of insecticide application, were much higher than those in colonies which had not contact any insecticides. The affinities of AChE to substrate was reducing, the insecticide resistance had a tendency to develop rapidly.(2) However, the parameters in colony which had contacted Propoxur and introduced by 10% susceptible flies for each generation were much the same as parameters of the susceptible colony. The insecticides resistance did not develop. For preventing or delaying the formation of insecticide resistance, the following suggestions were made: (1) IPM should be persisted, pestcides sprays could cut down as much as possible. (2) The area to encourage the dilution of the gene pool by immigration of susceptible individuals from untreated areas; and the "checker-board" method of insecticide application was generally a failure, therefore this method was not acceptable.

PERSISTENCE AND EXTINCTION OF 1 HOST-2 PARASITOIDS SYSTEMS: EXPERIMENTAL AND MODEL ANALYSES
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Theories of community ecology predict that systems with more consumer species than resources are unlikely to persist (e.g., MacArthur, 1972). However, Armstrong and McGhee (1980) showed that fluctuation in 1 resource-2 consumers systems enable all 3 species to coexist if functional responses of 2 consumers reversal within the dynamical range of the resource. These conditions had been already suggested by Utida's (1957) classic experiment with 1 host (a bean weevil) and 2 parasitoids (pteromalid and braconid wasps).

The present study analyzed factors enhancing persistence of Utida's system. I investigated dynamics in variations of this system with different experimental conditions. Persistence of a system greatly depended on the parasitizing ability of the pteromalid wasp, which varied not only with the grain size of the azuki bean but also with patch fragmentation of hosts suitable to parasitize.

I conducted simulations for dynamics of these systems and estimated relative importance of these factors on the persistence of the total system.

A MATHEMATICAL MODEL OF POPULATION TREND FOR HOMOPTEROUS AND OTHER INSECT PESTS. Xiong-fei Pang (South China Agricultural University, Guangzhou,510642,China)

A mathematical model of the index of population trend(I),based on the Morris-Watt mathematical model, was constructed for homopterous and other insect pest with long period of adult stage:

$$I=S_1S_2S_3\ldots.S_kFP_fP_{\varphi}\Sigma P_{fi}(S_{Aa})^i$$

In this model,the survival rate of states($S_1,S_2,\ldots,S_k$),the fecundity (FP_FP_{φ}), the sum of multiplier of survival rates of stage per day $(S_{Aa})^i$ and the fecundity rate per day(P_{fi}),$\Sigma P_{fi}(S_{Aa})^i$ was introduced as the components to the medol. For *Nilaparvata lugens*, $(S_{Aa})^i$ were decreased daily by natural enemies,P_{fi} were changed when the adult feeding on various resistant rice varieties. This coefficient $\Sigma P_{fi}(S_{Aa})^i$ plays an important role in the natural populations.

MATHEMATICAL MODELS ON THE RELATIONSHIPS BETWEEN THE SPATIAL DISTRIBUTION PATTERN OF PESTS AND CROP LOSSES. Yanqin Ding (Institute of Zoology, Academia Sinica, Beijing 100080, China.)

Spatial distribution of pests in field is usually of two patterns: random distribution and negative binomial distribution. Different spatial patterns bring about different injury degrees to crops and so different crop losses. There are three types of crop reaction to pest injuries: susceptive type, tolerant type, and overcompensatory type. When pests are of random distribution, mathematical models of crop losses (L) are as following : (1) susceptive type crop: $L= NP\ [a+b\ (1-e^{-m})]$

(2) tolerant type crop: $L= NP\left[\frac{K(1-e^{-m})^r}{B+(1-e^{-m})^r}\right]$ When $D>D^*$, $L=0$ When $D<D^*$

(3) overcompensatory type crop: $L= NP\left[\frac{K(1-e^{-m})^r}{B+(1-e^{-m})^r}\right]$ When $D>D^*$, $L=NP[-(a'+b'(1-e^{-m}) - c'(1-e^{-m})^2)]$ When $D<D^*$ When pests are of negative binomial distribution, mathematical models of crop losses are as following: (1) susceptive type crop: $L=NP\ [a+b(1-(1+\frac{m}{k})^{-k})]$ (2) tolerant type crop: $L=NP\left[\frac{K\left[1-(1+\frac{m}{k})^{-k}\right]^r}{B+\left[1-(1+\frac{m}{k})^{-k}\right]^r}\right]$ When $D>D^*$ $L=0$ when $D<D^*$ (3) Overcompensatory type crop: $L=NP\left[\frac{K\left[1-(1+\frac{m}{k})^{-k}\right]^r}{B+\left[1-(1+\frac{m}{k})^{-k}\right]^r}\right]$ When $D>D^*$ $L=NP\left[-\left\{a'+b'\left(1-(1+\frac{m}{k})^{-k}\right)-c'\left(1-(1+\frac{m}{k})^{-k}\right)^2\right\}\right]$ When $D<D^*$ m-population density of pests, k-k index of negative binomial distribution N, P-yield and price of crop without pest injury, D-injury level, D^* -economic injury level, a, b, c, B, K, r are parameters.

FRACTALS IN INSECT SPATIAL PATTERNS
Bai-lian Li (Center for Biosystems Modelling, Department of Industrial Engineering, Texas A&M University, College Station, TX 77843-3131, USA), Zuo-Rui Shen (Department of Plant Protection, Beijing Agricultural University, Beijing, 100094, China)

Spatial pattern analysis in insect ecology is the quantitative description of the 2-D or 3-D distribution of individuals of a species within a homogeneous or heterogeneous insect community, where this distribution may be random, regular, or aggregated. Approaches to the analysis of spatial patterns originally centered on statistical tests of randomness, e.g. use of the Poisson distribution, and spatial indices based on scattered quadrats. However, many insect dispersion patterns are non-random, and the identification of pattern and these indices are scale-dependent. Mandelbrot's concept of a fractal extends our usual ideas of classical geometry beyond those of point, line, circle and so on into the realm of the irregular, disjoint and singular. Fractals will provide us a new way to understand, analyze and simulate insect spatial patterns.

In this paper, we will introduce some concepts and methods of fractal geometry into insect spatial pattern analysis, such as box-counting fractals, information fractals, statistical fractals, etc. Fractional Brownian motion as modelling insect spatial distributions linking with image synthesis and geographic information systems (GIS) is considered in practice. From fractal point of view, mechanism of insect patch formation, ecological consequences of the spatial fractal structure (distribution of sizes of organism, distribution of geographical ranges of organisms and distribution of abundances in an insect community), and multiple scale sampling are discussed.

FEMALE MATECHOICE IN THE AUSTRALIAN SHEEP BLOWFLY *Lucilia cuprina*. David Cook, (CSIRO Division of Entomology, GPO Box 1700, Canberra ACT 2601, Australia).

Protein-fed *L.cuprina* females were paired with both a deleterious, translocation strain male (TS), used extensively in trials for the genetic control of *L.cuprina*, and a wild-type male (WILD). Both WILD and TS males were reared under identical conditions. Analysis of the mating outcome supported the good-genes hypothesis for female choice. Females exercised mate discrimination in favour of WILD males over TS males when first becoming receptive to mating, even though both male genotypes had directed an equal number of mating attempts at the female. This mate discrimination appears short-lived as when females proceed beyond first becoming receptive, their propensity to mate increases and they essentially mate with the first male they encounter. These results have implications for the genetic control of *L.cuprina* , as the period between field females becoming receptive and mating is estimated to be within hours, hence females are mating at a time when mate discrimination is presumably active. In addition, females rarely mate more than once and a single mating generally provides females with enough sperm for their lifetime egg production. This study explains in part why released TS males have low competitiveness relative to WILD males due to female mate choice.

ON THE USE OF SOME QUALITATIVE TRAITS FOR STUDY OF THE ANTS OF FORMICA GENUS. A.V.Gilev (Institute of Plant and Animal Ecology, Ural Branch of the Academy of Science of Russia, 8 March Street,202, Ekaterinburg, 620219, Russia)

The discrete veriations of the pigmentation on the pronotum of the Formica ants were found . Six variations of the pigmentation distinguishing in presence of certain patchs and in extent their junction were described. All these veriations or most of them were found in F. (Formica) rufa L., F.(F.) polyctena Forst.,F.(F.)aquilonia Yarr.F.(F.)pratensis Retz., F. (Serviformica) uralensis Ruzs. Similar sequences of variation are supposed to exist in all species of the subgenus Serviformica. The possibility to use the pigmentation traits for separating any groupings within species and within population is discussed.

SPERMATOPHORE SIZE AND ITS EFFECTS ON MALE AND FEMALE REPRODUCTION IN THE ARMYWORM, PSEUDALETIA SEPARATA. Yibin He, (Lab. Appl. Entomol. & Nematol., Fac. of Agri., Nagoya Univ., Nagoya 464, Japan)

In the armyworm, Pseudaletia separata Walker, males emerged from crowded larvae produced larger spermatophores than males from solitary larvae, despite the fact that the adult body size was not different between the 2 types. Spermatophore size increased with male age or time interval between the previous and current matings. Compared with females that received small spermatophores at 1st matings, females that received large ones showed neither higher fecundity nor longer life-span but experienced delayed rematings. And there is no more benefit for females that mated twice during adulthood than those that mated only once in terms of fecundity and life-span. On the other hand, males that produced large spermatophores did not show shorter life-span or delayed rematings than those that produced small ones. The results suggested that the production of large spermatophore may be evolved for the males to get more eggs fertilized by their own sperm by keeping their female mates from remating longer, especially when the competitions between males for females or the probability for females to remate are higher.

A COMPARATIVE STUDY ON SPERMATOPHORE SIZE IN BUSH-CRICKETS: EVIDENCE FOR NUPTIAL GIFT SIZE AS A SPERM PROTECTION DEVICE. Nina Wedell (Dept. of Zoology, Univ. of Stockholm, S-106 91 Stockholm, Sweden).

Males of many insect species provide the female, during courtship and copulation, with a nuptial gift of a prey item or synthesized material. These gifts may be explained as a form of paternal investment by increasing female reproductive output, or in terms of mating effort by increasing male fertilization success. These explanations, while not mutually exclusive, are controversial. This controversy may partly be the result of a failure to distinguish between the evolution and maintenance of this behaviour. While experimental studies can show the latter, comparative studies may be required to indicate evolutionary trends. Analysis of comparative data of 28 species of bush-crickets (Orthoptera: Tettigoniidae), reveals that male spermatophore size is positively correlated with female refractory period, which influences male fertilization success. Also, gift size was found to covary with ejaculate size, indicating that it functions to protect the ejaculate. In contrast, there is no significant correlation between any measures of female fecundity and male spermatophore size. This indicates that the variation in spermatophore size among tettigoniids has been influenced by a mating effort function rather than a paternal investment function.

ECOLOGICAL DIFFERENCES AMONG THE GENETIC VARIATION TYPES OF THE LADY-BIRD BEETLE, *HARMONIA AXYRIDIS* PALL. Rong-ping Kuang, Ning-nian Xiao (Kunming Institute of Zoology, Academia Sinica, Kunming, 650107, China).

This paper dealt with the comparative ecology of four types of variations in the color patterns of the lady-bird beetle, *Harmonia axyridis* Pall. Based on the investigation of frequency distribution of these types in natural population, We studied the life history , reproduction, survivorship and the intrinsic ability of population growth under given experimental conditions. These types of variations showed the significant differences in these ecological traits and ecological processes. These differences will help us understand the evolution of frequency distribution of variation types and dynamics of natural population in time and space.

GENETIC ANALYSIS OF THE WING-FORM DETERMINATION OF THE WHITE-BACKED PLANTHOPPER, *Sogatella furcifera* (HEMIPTERA: DELPHACIDAE). Masaya MATSUMURA (Hokuriku National Agricultural Experiment Station, Joetsu, Niigata 943-01, Japan)

The females of the white-backed planthopper, *Sogatella furcifera* exhibit wing-form dimorphism, i.e., macropter and brachypter. Wing-form ratio mostly depends on densities during nymphal stages. The genetic basis of wing-form determination was analyzed by selection and crossing experiment. The selection for macroptery and brachyptery was imposed for 12 generations. Response to selection for both macroptery and brachyptery was rapid and similar. Realized heritability for wing-form was estimated from the regression of cumulative response to selection on the cumulative selection differential for female of macropter, and was 0.259. Reciprocal crosses were made between the 10th generation of the two selected lines. F1 and F2 progeny, and of the backcrosses were examined for the relationship between nymphal density and wing-form ratio. Results clearly demonstrated a genetic component to wing-form determination and indicated a polygenic mode of inheritance. The data were applied to the liability model for quantitative genetics proposed by FALCONER (1989). The analysis suggested that the wing-form determination was a threshold character under polygenic control. The heritability in a broad sense estimated from the variances of F1 and F2 generations was 0.467.

GALL-MIDGES (DIPTERA,CECIDOMYIIDAE) ON THE ARBORESCENT-SHRUB PLANTS IN KAZAKHSTAN. Z.A.Fedotova (Inst. Zool.Kazakh Academy of Science, Academgorodok, Alma-Ata, 480032, USSR).

231 gall-midges species from 39 genera and 4 tribes were noted. They damage 124 species of arborescent-shrub plants, belonging to 38 genera from 19 families. 98 species of plants are dominants of vegetation. The largest number of species were found on Chenopodiaceae (138), Tamaricaceae (24) and Fabaceae (23). Monophagous were found only on Betula,Calophaca,Ceratoides,Convolvulus,Cotoneaster,Elaeagnus Ephedra,Halostachis,Hammada,Hulthemia,Juniperus,Pentaphylloides,Ribes,Spiraeanthus.The other species are narrow oligophagous, which damage their fodder plants together with complex of other such spicies. The most large complex of other such species.The most large complex is on Haloxylon (45 species),Salsola (32),Salix (22),Tamarix (18), Caragana (7).In the desert area 135 species were noted, in mountains - 82.Specific(220) with respect to arborescent-shrub plants are the following genera:Etsuhoa,Desertomyia, Kaltenbachiola, Massalongia,Psectrosema,Tricholaba, Xerephedromyia. Among rare plants gall-midges damage Calophaca soongorica (5 species),Salsola chiwensis (3),Spiraeanthus schrenkianus (1),Atraphaxis muschketowii (1).152 species are relative endemics.

THE APHID CTENOCALLIS ISRAELICA KILLS ITS HOST BUSH IN A POST FIRE FOREST IN MT. CARMEL, ISRAEL. Meir Broza, Chava Lahav, Ido Izhaki (Oranim, Haifa University, Tivon 36910, Israel).

The aphid Ctenocallis israelica is a rare and endemic species to Israel and feeds on Caliocotome villosa bush only. An outbreak of Ctenocallis population was observed two years after a recent fire on Mt. Carmel. The aphids infested 98% of seedling and sprouting bushes. Later on, seedling shoots were distorted and this halted growth. Seedlings death followed, reaching up to 85% of the plants population. A generalist aphid, Aphis craccivora, infested the same bushes during the same period but did not cause mortality of the host. The extraordinarily high mortality of C. villosa is in contrast to the published data on specialist herbivorous insects, including observations on Homopteran populations in post fire systems [Mills in Oecologia, 64:142, 1984]. The bush C. villosa is the most serious weed of planted pine forests in Israel, blocking with its spines the approach to the forest. The aphid mentioned above, appear to be a natural control agent of this weed.

THE PERFORMANCE OF CABBAGE APHID, BREVICORYNE BRASSICAE(L.) IN RELATION TO LEAF SECONDARY PLANT SUBSTANCES AND NITROGEN. Fawzi S.Al-Zubaidi (Babylon University,College of Science, Babylon-IRAQ),Laith Al-ARAJII.

A series of experiments were conducted to evaluate the probable role of some secondary plant substances and leaf nitrogen in the suitability of some host plants for cabbage aphid, Brevicoyne brassicae (L.). The obtained data clearly indicated that the host plants tested differentially affected the biological performance of cabbage aphid. Phenolic compounds concentration were found to be the most important factor in host plant suitability. Inverse correlation was found between the overall aphid performance and phenolic compounds concentration. The present study suggested that allyliosothiocyanates may have a role in the resistant of raddish plants used in this study.

SUITABILITY OF CONIFERS AS HOST PLANTS FOR *LYGUS* BUGS (HEMIPTERA: MIRIDAE) J.K. Holopainen, Ecological Laboratory, Department of Environmental Sciences, University of Kuopio, P.O.B. 1627, SF-70211 Kuopio, Finland.

Lygus bugs which have one of the widest documented host plant ranges have accepted nursery-grown conifer seedlings as host plants only recently. One explanation for this adaptation to the conifer nursery environment could be the increased attractiveness of conifer seedlings due to fertilization and herbicide treatments. Laboratory experiments with Scots pine seedlings to test this hypothesis indicated that the number of feeding lesions caused by *Lygus rugulipennis* Popp. and the number of eggs laid per seedling were not affected by the treatments with the herbicide atrazine. The analysis of the chemical value of the pine seedlings showed that the levels of total amino acids, monoterpenes and resin acids were not affected by the herbicide treatments. The increase in the availability of nitrogen resulted in increased number of eggs laid on pine seedling. Nitrogen treatments also reduced the concentration of total phenolics, but the concentration of monoterpenes was not affected. The factors affecting the *Lygus* resistance in conifer seedlings is discussed.

APHID HOST FINDING BEHAVIOUR: THE ROLE OF PLANT VOLATILES. Stephen F. Nottingham, Jim Hardie (AFRC Linked group in Aphid Biology, Imperial College at Silwood Park, Ascot, Berks SL5 7PY, UK), Lester J. Wadhams (Insecticides Department, Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ, UK).

For many years plant odour was thought to be unimportant in aphid host finding behaviour. However, aphids have now been shown to detect and respond to a range of plant volatiles. In an olfactometer, black bean aphids (Aphis fabae Scop.) were attracted to host plant leaf odour (Vicia faba Moench). The addition of non-host odours from tansy (Tanacetum vulgare L.), summer savoury (Satureja hortensis L.) and catnip (Nepeta cataria L.), however, inhibited this attraction, while sage (Salvia officinalis L.) had no effect.

An automated wind tunnel was modified so that visual and olfactory stimuli were presented simultaneously to flying summer migrants of A. fabae. Preliminary data showed some evidence for differential responses to a green target in bean (host) and tansy (non-host) odour.

Beans were interplanted with tansy, summer savoury, catnip and sage to test whether these herbs could disrupt the host finding behaviour of A. fabae in the field. During the summer migration significant differences in numbers of alates occurred between the beans only and intercropped plots, in a manner consistent with the olfacometer data.

ROLE OF PUBESCENCE IN RESISTANCE OF CASSAVA TO GREEN SPIDER MITE, MONONYCHELLUS TANAJOA. Hiroo Kanno (Tohoku National Agricultural Experiment Station, Omagari, Akita 014-01, Japan), San Ki Hahn (International Institute of Tropical Agriculture, Ibadan, Nigeria)

Resistance of cassava to green spider mite (CGM) was investigated in Nigeria during the dry season using randomly selected genotypes of cassava with varying levels of pubescence on young leaves in apical shoots. There was a significant negative relationship between trichome density on the young leaves and degree of plant damage caused by CGM. Most of the genotypes which exhibited high level of resistance to CGM were highly pubescent. There was also a negative relationship between trichome density and number of mites on young leaves. The quantity of excretion of the 100 mites on a leaf was much less when they were fed on the pubescent young leaves than on the glabrous leaves, indicating that feeding of mites on such pubescent leaves was suppressed due to the trichomes. The pubescence therefore indicates to be an important factor associated with resistance of cassava to CGM. Several other aspects of the resistance are also discussed.

THE RELATIONSHIP BETWEEN ANT FAUNA AND VEGETATION TYPES ON THE MOUNTAIN ZONE OF THE CENTRAL JAPAN. Masaki Kondoh (*Shiraume Gakuen College, Kodaira, Tokyo 187 Japan*)

Ant communities were studied by the honey-trap method at the several vegetation types belonging to mountain zone (480 — 1390 m) in Gumma Prefecture, Central Japan. These regions correspond to 90 — 100 m.d. of Kira's warm index. The ant fauna of vegetable field and abondened farmland consisted of *Paratrechina flavipes*, *Lasius niger*, *Formica japonica* and *Aphaenogaster famelica* being low coverages. *Paratrechina flavipes* and *Pheidole fervida* were common through the woody vegetations. But *Lasius niger*, *Formica japonica*, *Crematogaster osakensis* and *Aphaenogaster famelica* jointed of them under woodland-type vegetations, such as chestnut gardens, mulberry plantations etc. and *Aphaenogaster japonica* jointed of them under forest-type vegetations, such as cryptomeria and larch plantations and oak and other deciduous forests. *Formica* sp. was found at the wayside under the forest.
Nine saterite species were found under woodland-type vegetations instead of four saterite species under forest-type vegetations.

RESPONSES OF *HALOTYDEUS DESTRUCTOR* (ACARINA:PENTHALEIDAE) TO RESISTANT *TRIFOLIUM SUBTERRANEUM* VARIETIES.
T.J. Ridsdill-Smith (CSIRO Division of Entomology, Private Bag, Wembley, WA 6014, Australia)

Redlegged earth mite (RLEM), *Halotydeus destructor* (Tucker), is a major pest of pasture legumes in southern Australia. Plant/mite interactions between RLEM and a number of resistant and susceptible varieties of subterranean clover, *Trifolium subterraneum* (L.), were investigated in the laboratory. Resistance to the mites was expressed in the seedlings. RLEM pierced cells on the upper surface of leaves, and fed on the exudates, leaving a silvering of the leaf. Mites preferred to feed on young cotyledons, and the proportion of cotyledon leaf surface which was silvered was used as a measure of feeding. Seven days after planting seeds, RLEM were added to the seedlings and allowed to feed for 14 days. On seedlings of resistant varieties RLEM weighed less, females developed fewer eggs, and mites produced fewer progeny. Mite survival was not affected by resistant varieties. The basis of resistance was probably antibiosis since RLEM fed less on resistant plants and developed fewer eggs. Mites fed twice as much on the cotyledons of susceptible varieties as on resistant varieties. Since RLEM fed less on resistant varieties, it would be expected that foliage of the resistant varieties would grow more, but this did not occur. Reduction in foliage yield/pot due to mite feeding was no less in resistant than susceptible varieties.

RESISTANCE OF OATS TO CEREAL APHIDS: ALTERATION BY ROOT-KNOT NEMATODES WITH PARTICULAR RESPECT TO PHLOEM SAP COMPOSITION.
P. Sell (Institut für Angewandte Botanik der Universität, Marseillerstr. 7, 2000 Hamburg 36, Germany), H.-L. Kuo-Sell (Institut für Pflanzenpathologie und Pflanzenschutz der Universität, Grisebachstr. 6, 3400 Göttingen, Germany)

Two oat varieties, Leanda (L) and Flämingsstern (F), were found previously to be of different host suitability for the cereal aphid, *Metopolophium dirhodum*, whereby L was susceptible and F partially resistant. Both varieties were, however, good hosts for a probably new species of root-knot nematodes (*Meloidogyne* sp.) found recently in Hamburg, Germany. In the present study survival, fecundity and biomass production of *M. dirhodum* were investigated on nematode-free and nematode-infested plants of the two varieties. Results showed that nematode-infestation increased the resistance of both varieties to the aphids. The susceptible variety L became as resistant as F and the resistance of F increased to a higher level. At the same time, pure phloem sap of both varieties with and without nematodes were collected by aphid technique using a ruby laser. Results of sugar and amino acid analysis revealed that independent of varieties nematodes induced similar changes in the phloem sap composition. It became evident that changes in the sugar/amino acid-ratio, the Asn+Gln/Asp+Glu-ratio and the content of some single amino acids may be the reasons for the nematode enhanced host plant resistance to aphids in oats.

ASSEMBLAGES OF DYTISCID PREDATORS AND CULICID PREY IN RELATION TO POOL AREA, DEPTH, TEMPERATURE, AND PERMANENCE IN A NORTHERN WET SPRUCE FOREST AND AN ADJACENT CLEARING.
A.N. Nilsson (Department of Animal Ecology, University of Umeå, S-901 87 Umeå, Sweden) and B.W. Svensson (Department of Zoology, Section of Entomology, Uppsala University, Box 561, S-751 22 Uppsala, Sweden)

Assemblages of diving beetles (Dytiscidae) and immature mosquito stages (Culicidae) were studied during 1987-1988 in 40 small, more or less temporary, snowmelt pools in a wet spruce forest and on an adjacent clearing at the Arctic Circle in Sweden.
Larger pools were warmer than smaller ones, and pools on the clearing were warmer than those in the forest. Temperature differences between pools remained high until late July. Twenty-one dytiscid species, representing 3 guilds, occurred in the pools, and individual pools had 1-13 species. Ten species occurred in both areas. A few stenotopic species of wet boreal forests had on the clearing apparently been replaced by some species with a preference for more productive, often man-made habitats. Dytiscid species richness and abundance (except on the clearing) were positively correlated with pool area, pool depth and temperature. Species richness correlated negatively with drought frequency in the forest.
Six Aedes species were collected in the clearing pools. Five of these species were also found in the forest pools, of which three had no mosquito larvae. Culicid species richness and abundance were both positively related to pool area, depth and temperature.
In the forest, species richness and abundance of both dytiscids and culicids were all correlated. On the clearing, dytiscid abundance was not correlated to the three other biotic variables.
Distribution and mean abundance for individual species were only significantly related in the clearing pools. Larger dytiscid species were less abundant and occupied larger and warmer pools than smaller ones. Hydroporus melanarius occurred in all pools, whereas other species appeared to have minimum pool-size requirements, partly correlated with body length.
Flying dytiscids were trapped in the larger (1.6 m2), but not in the smaller (0.07 m2) artificial pools, and the immigration rate was markedly higher on the clearing than in the forest. Pool colonization rates were clearly affected by factors other than the degree of pool isolation. Dug pools were colonized faster on the clearing than in the forest. Even the flightless H. melanarius colonized dug pools during the first year.

CHEMICALLY MEDIATED MUTUALISTIC INTERACTIONS BETWEEN PLANTS AND PREDATORS.
Junji Takabayashi, Shozo Takahashi (Pesticide Research Institute Faculty of Agriculture, Kyoto University, Kyoto 606, Japan)
Marcel Dicke (Department of Entomology, Agricultural University, P.O.B.8031, 6700EH Wageningen, The Netherlands)

When considering tritrophic interactions in systems consisting of plants (first trophic level), herbivores (second trophic level) and predators (third trophic level), one of the intriguing questions is how predators effectively find their prey in the habitat. This has usually been answered from the viewpoints on predators. Chemicals are important cues used by predators in locating their prey.

The above question can also focus on the first trophic level (plants). Plants may defend themselves against herbivores indirectly by attracting natural enemies of the herbivores with chemicals.

Plants that have such indirect defence mechanisms are not passive interactants. Predators that are able to use such chemicals to improve effectiveness of prey location will have higher fitness than conspecifics that do not have this ability. Thus a mutualistic interaction is expected between plants and predators, and these processes will continue unless they are constrained by costs.

In this paper, we will present data of such mutualistic interactions in tritrophic systems consisting of plants, herbivores and predatory mites/parasitic wasps.

THE FORMATION OF HOST-PARASITE COMPLEXES ON RICE LEPIDOPTEROUS PESTS AND THEIR NATURAL ENEMIES IN VIETNAM.
Vu Quang Con (Institute of Ecology and Biological Resources National Centre for Scientific of Vietnam, Tuliem - Hanoi, Vietnam.)

There are 59 species of parasites recorded from rice lepidopterous pests. They form 9 main parasite complexes(PC) in which PC of the rice yellow stemborer and the rice leaf folder are more rich. The formation and development of CP little depend on the phylogenes of host but certainly relate with host life mode in which the damaging way on plants is important.

In PC the quantity position of species is not coincided with the quality because different activity of parasites and their different number developing in one host. The positive dependence exists between host population density and number of species in PC.

The coexistence of species in PC of host eggs, larvae, pupae are discovered. In large PC the propability of coexistence increases but in small PC it decrease. The first case reduce parasitism of host by every one parasite species and increases spotty distribution of species that reduces the interspecific competition.

CHEMISTRY AND COEVOLUTION AT THE INTERFACE BETWEEN NEOTROPICAL BUTTERFLIES (ITHOMIINAE, PAPILIONINAE) AND THEIR NATURAL HOST PLANTS. Keith S. Brown Jr., Clécio Klitzke, José Roberto Trigo, Silvana A. Henriques, Carina Berlingeri, P. E.Rubbo-dos-Santos, André V.L.Freitas & Paulo César Motta (Deptº Zoologia, Inst.Biologia, UNICAMP, C.P.6109, Campinas, SP, Brazil).

Standard mild extraction and fractionation methods were developed to give active chemical classes and compounds (terpenes, acids, phenolics, alkaloids, glycosides) from host plants used by local populations of Ithomiinae (Solanaceae, Apocynaceae; 42/5 species) and Papilioninae (14 Aristolochiaceae, 4 Rutaceae, 3 Annonaceae, 3 Lauraceae, 2 Magnoliaceae, 2 Piperaceae) and also from adult insects whose larvae fed on these plants, in order to test hypotheses of biochemical coevolution, chemical defense, and chemical mediation of host selection. Confrontation of phylogenies of Ithomiinae genera and their hosts indicated that, after the shift in the New World from Apocynaceae to Solanaceae, the adapting radiations of Ithomiinae colonized progressively more primitive hosts, by preadaptation to the new defensive chemicals they contained; only one species (Placidula euryanassa) stores larval host plant defensive chemicals (tropane alkaloids in Brugmansia) in adults. In contrast, advancing Troidini swallowtail species track closely the evolutionary progression of their Aristolochia hosts, storing a variety of their defensive chemicals (aristolochic acids-AAs, and alkaloids); advanced Aristolochia produced compounds that are antifeedant and toxic to most Troidini, and remove the phagostimulant AAs from the leaves. Other swallowtails, feeding on different families of toxic plants, do not reveal such clear patterns of chemical interaction and coevolution with their host plants.

PRESERVED GRASSHOPPER DEPOSITS IN THE GLACIERS OF THE ROCKY MOUNTAINS, U.S.A. Jeffrey A. Lockwood, Larry D. DeBrey (Department of Plant, Soil and Insect Sciences, University of Wyoming, Laramie, WY, 82071, USA), and Richard A. Nunamaker (USDA-ARS, Arthropod-borne Animal Diseases Laboratory, Laramie, WY, 82071, USA)

All four of the glaciers that we have studied since 1988 have undergone extensive recession in the last 50 yr, and much of the preserved insect fauna has been lost. Grasshopper Glacier (Beartooth Mountains, Park Co., MT) contains 750 yr-old fragmented remains of what appears to be the extinct Rocky Mountain grasshopper, Melanoplus spretus. Grasshopper Glacier (Crazy Mountains, Park Co., MT) contains recent deposits of both local, alpine species and migratory, rangeland species. Grasshopper Glacier (Beartooth Mountains, Carbon Co. MT) contains very small amounts of grasshopper remains that also appear to be M. spretus, based on cluster analysis of mandible morphometrics. Knife Point Glacier (Wind River Mountains, Sublette Co. WY) contains stratified remains of grasshoppers representing some 150 years of periodic deposits of large swarms. Most of the remains are fragmented, but intact, whole bodies of M. spretus can be found at the foot of an ice fall.

THE EFFECTS OF THE DIVERSITY OF FOREST PLANT COMMUNITY ON THE PINE LAPPET CATERPILLAR(DENDROLIMUS SPECTABILIS BUTLER) POPULATION. Bao-jia Gao(Hebei Forestry College, Baoding 071000, China)

In order to approach that the effects of the complicated degree of the forest plant community on the stability of insect community and the balance of insect population, in this paper, the Relative Analysis, Stepwise Regression Method and Discriminant Method are applied to analyse the ecological effect of the compositional and structural diversity of the forest plant community on the pine lappet caterpillar population. The result shows that the family-species diversity and the vertical structure diversity of the forest plant community have a great influence on the pine lappet caterpillar population density, and for which they can also be used as good predictors.

The occurrence type of the pine lappet caterpillar is discriminated by the plant community structure parameters with Fisher Discriminant Method. The test for the discriminant tally with the actual situation completely. This can demonstrate quantitatively that the forest plant community can influence the balance of the dominant population in the insect community obviously and stably.

ECOLOGICAL SUCCESSION OF GRASSHOPPER COMMUNITY UNDER DIFFERENT GRAZING INTENSITIES

Kang Le and Chen Yonglin (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Vegetation, grasshopper density and species composition were monitered on the natural steppe from 1988-1989 in Inner Mongolia, China. The pastures sampled belong to 3 types of vegetation which were separately laid in 3 series of grazing succession. Each series consisted of 5 gradients of different grazing intensities. Along these gradiends, the species composition, population number and biomass of the grasshopers varied sensitively. To distinguish grasshopper's successive populations, the concepts of Neartude and Choosing Rules were used. By combining the Grey Relation with the Cluster Analysis, 11 grasshopper species were divided into 3 grazing ecological assemblages: increaser, decreaser and invader. The results from Correspondence Analysis and Factor Analysis proved that there were close successive relations among these assemblages, which varied with the plant species, biomass, height and coverage. The influence effect and reason in grazing on the grasshopper community were studied. The importance of some grasshopper indicators was also mentioned.

SPECIES COMPOSITION AND ABUNDANCE OF CITRUS APHIDS IN GREECE.

D.P.Lykouressis (Laboratory of Agricultural Zoology and Entomology, Agricultural University of Athens, 118 55 Athens, Greece.)

The population structure and abundance of citrus aphids were studied in an orange-grove (cv.Washington navel), from January to December 1986, in Korinthia region, Peloponessus, south Greece. The main species found were Aphis citricola van der Goot and Toxoptera aurantii (Boyer de Fonscolombe). Both species appeared almost simultaneously on the new growth at mid March and were present till mid May. They reappeared in October till November. Analysis of the population structure revealed that A.citricola was the dominant species if it compared with T.aurantii, developing much higher populations through the whole year. Although the former species has been recorded relatively recently on citrus in Greece, is very likely to be the key species for this crop . A.citricola remained on the new growth for a longer period than T.aurantii and developed higher population densities on the southern than the nothern side of the trees. On the contrary, T.aurantii showed a preference and developed higher numbers on the nothern than the southern side.

TROPHIC RELATIONS OF THE ARTHROPOD COMMUNITY IN PADDY FIELDS. You Minsheng (Dept. of Plant Protection, Fujian Agricultural College, Fuzhou 350002, China), Pang Xiongfei (Dept. of Plant Protection, South China Agricultural University, Guangzhou 530642, China)

This paper deals with the trophic structure and types of the arthropod community in paddy fields based on the data obtained from outdoor surveys and indoor experiments. In the ecosystem of paddy fields, complex food chains and food webs may be formed because of the interspecific relations of feeding, parasitism and predatism. According to the living patterns of the parasitic species in the food webs, the trophic structures of the arthropod community in the paddy fields of Fuzhou suburbs can be divided into three types: (1) no link of epiparasitism has been found in the food webs; (2) there are some links of epiparasitism in the food webs; and (3) there exist some links of double parasitism in the food webs. By using some of the knowledge and the operation rules of graph theory, a food web can not only be described as a signed directed graph (SDG), a set, or an adjacent matrix, but also be combined with others. The method has been proved valuable in the studies of trophic relations of a complex community.

STUDIES ON THE COMPETITION DYNAMICS FOR APPLE LEAVES BETWEEN HAWTHORN SPIDER MITE AND EUROPEAN RED MITE. Yun-long Xia, Dun-xiao Hu, Ke-xun Huang(Department of Plant Protection, Beijing Agricultural University, Beijing 100094,China)

This paper dealt with the competition dynamics for leaf source between hawthorn spider mite Tetranychus viennensis Zacher and European red mite Panonychus ulmi(Koch), as the two mite species coexisted in apple orchard. Pursueing investigations every two days in the whole growing season on the leaves each inoculated simultaneously with 3, 6, 9, 12, 15, 18 or 21 equal number of female mites of both species respectively, and time and space niche analysis were conducted. The results showed that 12-15 females/leaf, the medium amount, was in favor of the coexistence of the two mites; and there appears to be some regular differences between the densities of the two mite species occupying on different leaf sides.

Evaluation of the natural distribution density of bioecotypes of trichogramma species in East Mazandaran (Saary-Noor).
I.Najafi Navaie & H.Bayat Assady
Plant Pests and Diseases Research Laboratories Amool.
Plant Pests and Diseases Research Institute , Tehran

Surveys on tracing and locating active and permanent foci of Trichogramma species was carried out in East Mazandaran from 1985 to 1989. Twenty six bioecotypes from 5 species (T.maidis, T.cordubensis, T.semblidis, T.evanescens and T.brassicae) with different densities were collected. Some of these quantitative and qualitative differences were quite obvious from biological experiments of these wasps.

Surveys have revealed an obvious difference in percent natural parasitism of ecotypes in hillside areas such as Valideh, Golafshan and Sangtarashoon of Barry in comparison with valley and shore areas. Natural parasitism in late season on eggs of rice stemborer (Chilo suppressalis) and the European cornborer (Ostrinia nubilalis) has been on avarage 71.9% and 75.22% respectively in hill side regions and 10.87% and 32.47% respectively in valley and shore regions. The low parasitism in shore areas is due to the harmful, effects of pesticide use , high mortality of wasps in winter due to lack of suitable shelters, low density of winter hosts available, and factors in comparison with hill side habitats.

APPLIED INVESTIGATIONS OF THE CONTROL OF THE ABUNDANCE AND DAMAGE OF *CHILO SUPPRESSALIS* BY THE AMOL ECOTYPE OF *TRICHOGRAMMA* SPP. IN AMOL. Irage Najafi Navaie, Bayat Assady H. (Rice Research Station, Amol- Plant Pests and Diseases Research Institute, Tehran, Iran)

The parasitic wasp *Trichogramma*, has been collected from more than 20 locations of Sarry to Noor, from the eggs of hosts such as Rice Stem Borer, *Naranga* sp., European Corn Borer and a variety of flies from the family Ephydridae and Syrphidae. These species and ecotypes have been sent abroad by the Department of Biological Control for the purpose of identification. Specimens collected from Venisdeh, Golafshan, Ghaem Shahr and Nozamabad have been very active. In the surveys carried out, natural parasitism rates of 50-80% have been recorded for these species on the eggs of the Rice Stem Borer at the end of season. Experimental release trials were carried out at 3 intervals with the Amol ecotype wasps, in Hendokola, in a 3 hectare plot, with insectcide & control treatments (without insecticide treatments and release). Calculation of surveys at 6 intervals have revealed that the average rate of infestation of plants in the last survey before harvest, has had an increase of 9.6% in comparison with the insecticide treatment and a reduction of 40.7% in comparison with the control. In a similar manner with surveys and calculations of crop yields, the release treatment has shown a reduction of 4.2% crop yield relative to the insecticide treatment and an increase of 17.3% crop yields in comparison with the control.

ECOLOGICAL PREREQUISITES FOR USE OF INTERCROPPING TO CONTROL MAIZE STALKBORERS, *CHILO PARTELLUS* AND *BUSSEOLA FUSCA*, ON MAIZE IN KENYA. Samuel Kyamanywa (P.O. Box 16 Kikambala, Kenya)

Intercropping is emerging as one of the promising components of integrated management of stalkborers in maize. There are, however, conditions that ought to be fulfilled before it can be successfully exploited. Experiments conducted in different ecological zones of Kenya, have identified three important ecological factors which should be observed when considering intercropping for controlling stalkborer in Kenya. They are discussed in relation to current ecological concepts.

THE MACRO-ANALYSIS OF ECOLOGICAL CONTROL OF AGRICULTURAL BIO-DISASTERS AND THE PRINCIPLE OF ESTIMATION AND PREDICTION BY GREY SYSTEMS. Bao-ling Li, Fu-jiu Huang (Shaanxi Institute of Plant Protection, Yangling, Shaanxi 712100, China)

Bio-disaster is one of the important constraints affecting the stability of agricultural production.

The present paper deals with using the grey systems theory to analyse the ecological control mechanisms of agricultural bio-disasters. Many other factors and some related ecological positions in the controlling process of bio-disasters are shown in the grey system frame diagram, whose relations between cause and effect are also sorted out clearly, thus, playing a fixing-position role in the micro-analysis. The state structure model $S(t)=\{E(t); R(t); F(t)\}$ is used to conduct the dynamic simulation of factors, relations and functions in the system. Based on the analysis of the "rising and falling" variations in the factor of a single sysem, the dominant factors in the occurence of disasters are found out so as to establish the models gradually, while the holo-points in the fields can be selected to carry out the full-azimuth investigations in order to absorb and supplement new information into the models continuously to predict the establishment of models in steps until the instructions are determined. The systematic prediction has improved the accuracy greatly.

It has been proved that this method used in predicting cotton pests will be reliable in seven years.

THE CHANGE CAUSE OF GENERATION NUMBER OF CORN BORER OCCURRENCE IN THE CORN ZONE OF SONGLIAO PLAIN, JINLIN PROVINCE. Cheng-lun Wang (Jilin Academy of Agricultural Sciences, Jilin Province 136100, China)

Asian corn borer Ostrunia furnacalis is the most serious pest of corn in China. It also do harm to millet and sorghum. The occurrence law of Asian corn borer is very complicated and varied. In recent twenty years, corn hybrid varieties were applied broadly and corn yield increased doubly. Beacause corn-growing areas increases, planting structrue of corn changes a lot, the rotation of crops is limitation. In this ecological condition, the occurring law of corn borer also changes so much. Especially in nineteen eighty's, the moth of overwingterring corn borer occurred late than before. The number of generations also changed. It was the reason that the eggs laid on whorle-leave stage were from about 80% to reduce to 20% so that the effect of granules became. This paper discussed occurrnce of corn borer, crops distribution and the problem of control corn borer.

DAILY BIPHASIC BEHAVIOUR IN KERATIN-FEEDING DESERT TROGID BEETLES IN RELATION TO CLIMATE. C.H. Scholtz (Department of Entomology, University of Pretoria, Pretoria 0002, South Africa) S. Caveney (Department of Zoology, University of Western Ontario London, Canada N6A 5B7).

Patterns of daily activity of two ectothermic species of the trogid genus Omorgus were studied in the Kalahari of southern Africa in summer. The relationship between time and type of activity, and environmental temperature, relative humidity and light intensity, was investigated. Beetle activity was biphasic, with peaks in activity at sunset and sunrise in both species. Afternoon activity coincided with high temperatures and low humidity and morning activity with minimum daily temperature and maximum humidity. Afternoon activity, which peaked at about 34°C and 25%RH, consisted predominantly of complex breeding behaviour and dispersal. High temperatures are necessary for these activities. In the morning feeding predominated. At this time temperature was about 27°C and RH above 60%. High RH is important because it restricts respiratory loss of water, improves food (moist hair and skin keratin) quality and may compensate for fecal water loss. No evidence of competition between the two species was found.

A PRELIMINARY REPORT ON THE MECHANISM OF MBOA IN FEEDING BEHAVIOR OF NEONATE LARVAE OF THE ASIAN CORN BORER OSTRINIA FURNACALIS (GUENEE) AND ITS IMPORTANCE IN RESISTANCE STUDIES. Liang Xiao, (Plant Quarantine Institute, Ministry of Agriculture, Beijing 100026, China) Da-rong Zhou(Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Results obtained from feeding-station tests of neonate larvae of the Asian corn borer Ostrinia furnacalis (Guenee)(ACB), by using plugs of diet containing MBOA and other substances, indicated that MBOA mainly influenced the behavior of orientation of the neonate larvae and resulted in poor establishment. It did not inhibit the development of early-instar larvae and had very little effects on their survival after reared on freeze-dried artificial medium containing high concentration of this compound. Therefore, it was suggested that MBOA may act as a repellent which affects the behavior of the ACB larvae and increases the mortality of neonate larvae under field conditions through the influences of climatic and biological factors and may not be considered as a toxic factor affecting its metabolism and survivals. With this, the authors tried to illustrate the phenomena reported by Guthrie et al., i.e. resistant cultivars lost their resistance when grown under greenhouse conditions, although they still contained considerable level of DIMBOA in the whorl tissues.

SEASONAL ECOLOGY AND GEOGRAPHICAL DISTRIBUTION OF THE CONIFER SAWFLY, NEODIPRION SERTIFER (Geoff.). Donald R. Wallace, Forestry Canada - Ontario Region, Sault Ste. Marie, Ontario, Canada P6A 5M7.

The conifer sawfly, Neodiprion sertifer, has two diapausing stages, one embryonic and the second prepupal. In the usual developmental sequence at low elevations in mid-temperate latitudes, the embryonic diapause occurs in the autumn and provides the sawfly with overwintering and developmental synchronization mechanisms. The summer prepupal diapause serves to protect the eggs of the sawfly from harmful high temperatures. In an intense form of the prepupal diapause the long term survival of the sawfly is enhanced. The attributes of these diapause states and other developmental characteristics are discussed in relation to the temporal and spatial distribution of N. sertifer.

ROLE OF PRIMARY AND SECONDARY METABOLITES IN HOST-RACE FORMATION IN SPRUCE BUDWORM AND DOUGLAS-FIR. Rex G. Cates, Chemical Ecology Laboratory, Brigham Young University, Provo, Utah, 84602 USA.

Interactions between the budworm (Choristoneura occidentalis) and Douglas-fir (Pseudotsuga menziesii) are complex and have been influenced by a number of factors. Current knowledge of these interactions with regard to resistance mechanisms that influence host-race formation is the following: 1) Several types of variation are known to exist in the production of soluble carbohydrates, minerals, terpenes, sesquiterpenes, monomeric phenolics, and tannins among Douglas-fir populations, among individuals within a population, among years of the same population, during developmental stages within a growing season, among canopy levels, among branches of a single tree, and due to tree age. 2) Several terpenes, but particularly bornyl acetate, camphene, and sesquiterpenes, and the carbohydrate galactose, have been shown in field and laboratory experiments to adversely affect larval mortality, growth rate, pupal weight, and adult dry biomass production. 3) The budworm is as genetically variable as is Douglas-fir. Reciprocal transplants of budworm and laboratory feeding trials show that different populations of budworm respond differently to identical diets incorporated with terpenes, sesquiterpenes, nitrogen, and galactose. Future DNA studies using RAPDs will increase our understanding of the complexity of Douglas-fir resistance mechanisms.

THE DISTRIBUTION OF CRANBERRY FRUITWORM, *ACROBASIS VACINII*, IN MASSACHUSETTS, USA, CRANBERRY BOGS. A. K. O. Rogers and A. L. Averill (Department of Entomology, University of Massachusetts, Amherst, MA, 01003, USA).

The oligophagous cranberry fruitworm, *Acrobasis vaccinii* (Lepidoptera: Pyralidae), is an important pest of cranberry, *Vaccinium macrocarpon* (Ericaceae), in most areas of North America where the crop is grown. The adult female oviposits singly into the calyx of host fruits; upon hatching, the emerging larva eats its way into the fruit and feeds internally, consuming from three to six fruits in close proximity as it matures.

A two-year investigation of the distribution of eggs in five commercial cranberry bogs in Massachusetts, USA, has revealed a high degree of contagion on several spatial scales. Certain berries and areas of bog receive many more ovipositions that would be predicted by chance. The distribution of larvae is also contagious, but less so than eggs. Both ecological and behavioral factors contribute to nonrandomness in oviposition; these include, but are not limited to, proximity to the margin of the bog, berry accessibility, and berry size. The distributions of eggs and larvae have been characterized mathematically, and the effects of sampling method and pest density thereon explored.

OPPORTUNISTIC EGG DIAPAUSE OF THE ORIENTAL CHINCH BUG, CAVELERIUS SACCHARIVORUS OKAJIMA (HETEROPTERA: LYGAEIDAE), IN RELATION TO ITS WING POLYMORPHISM. Kenji Fujisaki (Laboratory of Applied Entomology, Faculty of Agriculture, Okayama University, Okayama 700, Japan)

The oriental chinch bug, Cavelerius saccharivorus, is an important pest of sugar cane in the subtropical region from Taiwan to the south western islands of Japan. This species has a wing polymorphism producing brachypters and macropters. Since only the macropters can fly, the wing polymorphism of this species is regarded to be a typical dispersal polymorphism. Females lay diapaused eggs from autumn to winter in response to short day length. The diapause is opportunistic because it was more easily broken by high temperatures above 25℃ rather than by low temperatures. It is probably a tactics of bet-hedging in the subtropical winter, when the temperatures fluctuate around the threshold temperature for the development of nymphs. Moreover, the diapause was more intense in the eggs laid by macropters than in those laid by brachypters. This indicates that the egg diapause of this species is a life history trait which is closely correlated with the wing form of mother.

GYNOPARA - MALE RATIOS IN THE APHID *MYZUS PERSICAE* AT DIFFERENT TEMPERATURES. Dinah F. Hales (School of Biological Sciences, Macquarie University, N.S.W., 2109, Australia) and Paul W. Wellings (CSIRO Division of Entomology, GPO Box 1700, Canberra, A.C.T. 2601, Australia).

Studies of sex allocation in aphids have shown, in one case, a constant investment in males, and in another, an equal investment in males and females. The host-alternating aphid *Myzus persicae* fits neither of these models. Individuals on the secondary host produce winged males and winged gynoparae: both these forms then fly to the primary host, where each gynopara gives birth parthenogenetically to 5-10 sexual females. We studied the time course of production of gynoparae and males, and concluded that the sex ratio depended on the survival time of the mother. There were two or more males to each gynopara when the experiment was conducted at 20°C; assuming all gynoparae and males reached the primary host, and that each gynopara produced 5 sexual females, the final sex ratio would be about 2 sexual females to one male. A constant temperature of 20°C, however, may be higher than the average autumn temperature in the field. We repeated the experiment at 15°C and found the proportion of males was much lower (1 male to 3 gynoparae). Making the same assumptions as before, the sex ratio on the primary host would be 15 sexual females to 1 male. Males are only 10-20% heavier than females at birth, so it is clear that investment in the two sexes is not equal at either of the temperatures used, but is dependent on temperature and on maternal survival.

STUDIES ON DISTANCE OF DISPERSAL AND POSSIBILITY OF MIGRATION IN ADULT OVERWTNTERING GENERATION ASIAN CORN BORER, OSTRINIA FUNACALIS (GUENEE), BY USING RELEASE-AND RECAPTURE TECHNTQUES. Da-rong Zhou, Zhen-ying Wang, Yan-ying, Song(Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Previous research showed that wild and artificial reared adult Asian corn borer(ACB) had the potential of long distance migration as shown in flight-mill tests, i.e. over 100km/24hrs. In 1987 and 1988, under the cooperation of five institutions, field experiments were carried out to determine the distance of dispersal and possibility of long distance migration in this insect. 150- and 600-thousands artificially reared high quality ACB adults, labelled internally with 0.01% of Calco Red or Sudan Blue 670(II), were released in the two years, respectively. Surrounded the releasing site, 9 circles of 102 pheromone traps were arranged with with a radius from 1 to 40km(in 1988, it was further extended to 200km) to recapture the males, no matter in which direction they would fly. The total number of recaptures was 460 and 2650 males, respectively. Among them, 95% of which were within the circle of 4km radius; a small amount were at the distance of 6 to 30km and the two 'champions' for the two years were both at the distance of 45.5km. The whole tendency of the two-year recaptures was highly similar. It was thus concluded that, at least, during the overwintering generation flight, the ACB adults did not perform long distance migration, although having the potential. This conclusion is of great importence in further ACB IPM research.

MIGRATION, DIAPAUSE AND LIFE-HISTORY OF MEADOW MOTH *Loxostege sticticalis* L. [Lepidoptera, Pyralidae] IN CHINA. Sun Ya-jie, Chen Rui-lu, Bao Xiang-zhi and Wang Su-yun (Jilin Academy of Agricultural Sciences, Jilin Province 136100, China)

Distribution of meadow moth, *Loxostege sticticalis* L., is wide from latitude 37° N to 50° N in north China. The survey of overwintering in 1978-1986 showed that there was a main overwintering area located between latitude 39° N to 42° N and longitude 110° E to 116° E. Experiment on diapause showed that diapause rates reached 50% and 90% respectively at photoperiod 13 hours with temperature 25.4℃ and 23.3℃, or 16 hours with 18.3℃ and 14. 5℃. Emigration of adult mass was observed by radar in the main overwintering area during the spring of 1984. Moths flighted downwind with southwestern wind. 1.8 million moths per kilometer flew over were observed in a night. When the wind direction was changed, the direction of migrants was changed with it. Life-history: 1. Main overwintering area: There were three generations in the plain area of altitude about 1000 metres, and two generations in the mountain and plateau area of altitude above 1400 metres. The moths emigrated in spring and formed the sources of all regions. In this area, the larvae period of last generation got photoperiod from 14 to 11 hours and average temperature from 22℃ to 13℃, which promoted forming a great number of diapause prepupae. 2. Dispersing area:There were two or three generations. Adults immigrated from main overwintering area in spring. The population number decreased abruptly from second generation. the larvae of last generation were much less.

IDENTIFICATION OF FLYING INSECTS USING AN ARTIFICIAL NEURAL NETWORK TO RECOGNIZE WINGBEAT SPECTRA. Aubrey Moore (Northern Marianas College, Saipan MP96950, U.S.A.)

Natural or artificial light reflected from the wings of an individual flying insect can be recorded using a photosensor. Spectral analysis of a typical recording reveals a harmonic series with the wingbeat frequency as the fundamental. Wingbeat spectra can be used to identify flying insects in much the same way the human ear and brain identify musical instruments by their characteristic audio spectra. In an experiment using the mosquitos Aedes aegypti (L.) and A. triseriatus (Say), an artificial neural network was trained to identify species and sex with high accuracy. This technology could provide the basis for an insect flight monitor which automatically counts and identifies species of interest.

OVERWINTERING AND MIGRATION OF PLUTELLA XYLOSTELLA IN NORTHEAST CHINA. Chunsen Ma, Ruilu Chen(Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Gongzhuling, Jilin, China)
1. Overwintering:a. Cold endurance test of the species showed that the cold hardiness of pupae were higher than other stages. b. The pupae could survive in soil gap untill mid December but died before late January. The larvae did not pupate in soil gap. Thousands of the larvae in remained cabbage plants died before mid December. Overwintering test on sunny and lee side showed that no individual was survival by March. c. No individual was found in overwintering investigation in remained cruciferous plant foliage and around weeds in April, 1988 in Changchun and Gongzhuling. 2. Migration:d. Flight capability of the moth was measured by a flight mill with computer processing system. The moth were tethered flight for 24 hours in still wind. Flight terms were 13.57 hours for females and 15.13 hours for males. The flight capability of the moth was stronger than many small migration insects. e. The catchs of the moth in pheromone trap increased or decreased abruptly and 3 peaks appeared from mid May to mid June. The catchs were significantly correlated with southwest wind and numbers of the oriental armyworm moth by light trap. f. Migration insects were sampled at 200 m above ground by using a kite to carry a net. 2 diamondback moth and 7 armyworm moth were cought on north shore of Bohai sea in June, 1989. It was supposed that the diamondback moth and the oriental armyworm moth immigrated into northeastern China with southwest wind in late spring.

AUTAMNAL MOVEMENTS OF MONARCH BUTTERFLIES ALONG THE GULF COAST IN FLORIDA. Minoru Ishii (Entomol. Lab., Coll. Agr., Univ. Osaka Pref.), Lincoln P. Brower (Dept. Zool., Univ. Florida) and Tonya Van Hook (Entomol. and Nematol. Dept., Univ. Florida)

Fall migratory movements of Monarch butterflies, Danaus plexippus L. were observed at St. Marks National Refuge along the Gulf Coast of Florida in October and November, 1991. We classified their movements into 3 categories: Going (flying seawards across the shore line on a westerly course and vanishing from sight); Coming (appearing westerly from the sea and flying easterly to the seashore) and Returning (flying out to the sea but then returning to the seashore).

Of the total of 280 monarchs seen moving between 29 October and 15 November, 42, 162 and 76 were Going, Coming and Returning, respectively. Coming monarchs occurred more frequently during notherly winds, while Going and Returning movements were seemingly unaffected by the wind. The number of monarchs nectaring and resting on the dike significantly increased when more monarchs came and the daily accumulated number of them on the dike was significantly correlated to that coming.

On the basis of the results, we will discuss the migration strategies of monarch butterflies along the Gulf Coast.

THE COMPUTER SIMULATION OF MIGRATION OF THE ORIENTAL ARMYWORM MOTHS, MYTHIMNA SEPARATA WALKER. Bohai Hu (Station of Crop Pest Forecast, Ministry of Agriculture, Beijing 100026, China)

This paper gives a result of application computer to simulate the migration of armyworm moths. 2 factors about number of moths and several meteorological factors are quite important for computer simulation. The main models are as follow:

Model for migration out

$$Mig01(x)=-21.27+0.91x_1+4.88x_2-0.01x_3-0.28x_4+0.56x_5+3.68x_6+1.42x_7$$

Model for local action

$$Mig00(x)=-11.86+0.58x_1+3.54x_2+0.01x_3+1.41x_4+0.08x_5-0.01x_6+1.04x_7$$

Model for migration in

$$Mig10(x)=-14.86+1.30x_1+3.62x_2+0.65x_4+0.33x_5+0.42x_6+1.15x_7$$

Model for proliferation

$$PLT(x,D)=0.46x\sqrt{D1^2+D2^2}$$

#1

THE EFFECT OF SOME PESTICIDES ON CEREAL PESTS AND BENEFICIAL ARTHROPODS IN WINTER WHEAT AND WINTER BARLEY. CH. VOLKMAR, TH. WETZEL, K. SCHMUTZLER (Institute of Phytopathology and Plant Protection Martin-Luther-University, Ludwig-Wucherer-Str. 2, O-4020 Halle/S.)

The results of fieldtrials with some pesticides (Deltamethrin, Methamidophos, Dimethoat, Pyrazophos, Propiconazol, Pyrazophos + Propiconazol and Fenpropimorph) in winter barley and winter wheat are presented. Apart from effects on cereal aphids, Thysanoptera frit fly and wheat midges the mortality of beneficial arthropods was observed. The number of insects pests were analysed in the laboratory. The number of spiders caught with pit fall traps.

In both years (1989-1991) the number of insect pests (Oscinella frit (L.), Thysanoptera) in winter barley was reduced by the application of all pesticides. The effectiveness of the pesticides in winter wheat was comparable to that in winter barley. The number of Araneae in winter barley after the application was influenced particulary by Pyrazophos, Propiconazol + Pyrazophos and Deltamethrin.

#2

DUAL CLIMATIC ADAPTATION IN THE SPOTTED CUTWORM MOTH: A CASE OF SHORT-RANGE MAIGRANT. Toshio Oku (Morioka Branch, Fruit Tree Research Station, Shimokuriyagawa, Morioka 020-01, Japan)

The spotted cutworm moth, Xestia c-nigrum (Linnaeus) is a well-known short-range migrant in the cooler temperate, of which the active period is delimited by a facultative diapause for hibernation at older larval instars. Experimental results and field records suggested that the species may adjust its seasonal life cycle to the local change of available heat by the following two ways:-

Adjustment to the latitudinal change. The bivoltine life cycle is kept at least up to 44 N in the plain by shortening of the generation time from south to north with a parallel change of body size, as are the ordinary cases of residentiary temperate insects. This clinal variation would not be strongly disturbed by the migration of short-range.

Adjustment to the altitudinal change. In the central Iwate, two separate flight peaks are observed up to subalpine areas, although the overwintering zone does not reach this level. No substantial differentiation in developmental time is detected among bivoltine populations from different heights, suggesting the gene flow among them due to migration. Adjustment of the active period to the altitudinal change of available heat may be realized by the special photoperiodic reaction, which allow to change the time for non-diapause development of older larva and pupa in the summer generation. Circumstantial evidence suggested the presence of a univoltine population segregated in a highland, but its permanence is still open to question.

#3

ULTILIZATION OF INSECT PROTEIN: THE PRELIMINARY STUDIES ON TECHNO-SYSTEM OF HOUSE FLY, MUSCA DOMESTICA VICINA MACQ. LARVAE PRODUCTION IN MEDIUM SCALE. Chang-zhen Zhong, Han-ping Lu (Department of Plant Protection, Huazhong Agricultural University, Wuhan 430070, China)

The larvae meal of house fly was high in protein, thus was considered as a good source of protein. The techniques of house fly larvae production were first studied as a techno-system by using system thinking and approach in this paper, in which the border, structure, function and main characters of techno-system were discussed. While general goal of techno-system was yield, it may be divided into two subsystems: the eggs production techno-system and the larvae production techno-system. The experiments were conducted with orthogonal, rotated and combinated designs of 3 factors: atmosphere temperature of fly cage (X_1), fly density (X_2) and light length(X_3) or atomosphere temperatre of larval rearing room(X_4), moisture content of medium(X_5), and larval rearing density(X_6). 7 fly oviposition models and 3 larval growth models were established by statistic analysis of electronic computer. After model analysis, the main effect and interaction between factors were discussed. According to computer simulation, fine production combinations of each model were screened from 125 combinations. Through comperhensive scoring and decision analysis, optimum combination of each model was obtained. The following aspects, such as light effect, moisture content effect, optimum moisture content of wheat bran, the vistas of regressive design and so on, were also discussed respectively in present paper.

#4

Prognosis of haronfulness insect-phytofages field crops and areas insecticidial treatment on the base of statistical modelling

V.P.Omeluta, Ukrainian Plant Protection Institute, Kiev, Ukraine, USSR

It is diseassing method of approach chronometrical and parametrical statistical modelling of many years harmfulness and volume of insecticidial treatment areas of field crops against Eurygaster integriceps Put., Leptinotarsa decemlineata Say., Bothynoderes punctiventris Germ., Chaetocnema concinna Marsch. and another.

#5

INFLUENCING FACTORS AND POSSIBLE MACHANISMS CONCERNING THE INTERACTIONS OF AIR POLLUTION ON INSECTS. Ya Wu, Cuixia Jin (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences, Nanjing 210014, China)

Based on the known information about the effects of air pollution on insects, several influencing factors and possible mechanisms may be outlined. They include different pollutants and their dosages, insect species and their development stages, rain water acidifications, natural selection as well as effects of natural enemies and so on. The evidence available demostrates that air pollutant-induced physicochemical changs in plants can affect insect success. Air pollution alters the amino acid content of plant and sugar concentrations. There changes in nutrients will often have some effects on insects feeding on these plants, so that the Epilachna varivestis M and Macrosphum rosae consume more plant leaves in O_3-polluted areas. Besides, the changes of defence mechanisms of the plants in air pollution environment will potentially disturb the relationship between plant and insect. It has been known that the defence chemical, such as glutathione can be taken directly by insects and inturn to protect them from pollution injury.

#6

THE EFFECT OF SIMULATED ACID RAIN ON SUSCEPTIBILITY OF THE EUROPEAN PINE SAWFLY (*NEODIPRION SERTIFER*) LARVAE TO NUCLEAR POLYHEDROSIS VIRUS. **Kari Saikkonen & Seppo Neuvonen** (University of Turku, Department of Biology, Laboratory of Ecological Zoology, SF-20500 Turku, Finland)

The European pine sawfly populations usually undergo large fluctuations in density and sometimes have local isolated mass-occurences on Scots pine (*Pinus sylvestris* L.). Nuclear polyhedrosis virus (NPV; Baculoviridae) has often been considered as important regulator of outbreaks. We studied whether simulated acid rain (SAR) affected the susceptibility of the European sawfly larvae to virus, and whether the results were similar when two different ages of larvae were infected. The study was conducted at the Kevo Subarctic Research Station (69° 45' N, 27° E) in Finnish Lapland. The host plant treatments (irrigation control, pH4- and pH3 irrigation) were conducted during five growing season. Pine needles given to the larvae were sprayed with dilute virus suspension (about 200 PIB's/ml) two days (groups A1 and A2) or eight days (groups B1 and B2) after the larvae started feeding on experimental foliage. Furthermore pH of previous year needles were measured of crushed needles and of water droplets on the needle surfaces. The susceptibility to virus was strongly reduced by ageing of larvae. Most larvae treated with virus two days after they started feeding on experimental foliage (group A), died rapidly after 10 days from the virus treatment. Larvae treated with virus one week later (group B) responded remarkable slower to virus. Survival at the end of the larval period was only 1.7 - 21.7 % in group A, while in group B it was 26.9 - 61.0 %. In group A1 the larval survival on pH 3 treatment was higher than in other treatments; at the end of the larval period the difference was 4-fold. With later virus infection (=older larvae; group B) there were no clear effects of SAR on the susceptibility to NPV. Our results show that simulated acid rain can reduce the susceptibility of very young *Neodiprion sertifer* larvae to the virus. SAR explained only pH of needle surfaces, but it had no statistically significant effect on larval susceptibility to NPV. Mechanisms how the acid rain may affect larval susceptibility is still unclear.

#7

ANALYSIS OF SPATIAL DISTRIBUTION OF ANT COMMUNITIES IN CEREAL FALLOW LAND SUCCESSION THROUGH DIVERSITY PARAMETERS. Serrano, J.M.; Acosta, F.J.; Gomá, J. & López, F. (Departamento de Ecología, Facultad de Biología, Universidad Complutense de Madrid, 28040 Madrid, Spain).

The total entropy theorem is employed in this study to analyze the changes in the spatial distribution of ant communities from cereal fallow lands of Central Spain. Species diversity, spatial niche amplitude, and intensity of spatial pattern were investigated in a static successional sequence constituted by several plots, ranging from 1 to 40 years of abandonment. Sequential arrays of pitfall traps (a total of 2000) were employed to collect ant workers. Sampling work was carried out in spring, summer, fall, and winter of 1983-84. More than 14000 individuals, distributed in 29 species, were found. Species diversity and spatial heterogeneity increase through succession. The spatial organization of these ant communities shows a fine-grained structure. Several species appear to have a certain degree of plasticity in their spatial distribution trends, changing their spatial niche amplitude strategy according to the different successional stages.

#8

MANAGEMENT OF THE SCARAB PEST COMPLEX OF CORN IN MEXICO: THE NEED OF A SUSTAINABLE AGRICULTURE APPROACH. F.J. Villalobos (Instituto de Ecologia, Apartado Postal 63, Xalapa 9100, Veracruz, Mexico).

Corn is the major crop in Mexico and the soil scarab larvae may cause severe losses. Estimates for losses due to Phyllophaga spp account for 0.4 -1.3 tonne/ha/year of the crop. The average yield of corn in Mexico is less than 2 tonne/ha/year and by controlling scarab larvae corn yield could increase up to 40%. Demand of corn in Mexico is presently estimated at around 15-16 tonnes/year and this is expected to rise up to 25 million tonnes/year by the turn of the century. Crop and pest management practices have been deleterious to the environment. DDT were used until 1986 at a rate of more than 40 hundred of tonnes/year. Extremely high soil erosion values have been recorded in Mexican corn fields (130 tonnes/ha/year). Recent information on the biology and ecology of the pest complex suggest ways to reduce damage. Manipulation of the soil environment and rhizosphere may have a positive effect on the encouragement of natural enemies, soil fertility and decrease in the pest damage. The Mexican MAB-UNESCO Biosfere Reserves are crucial in the research on sustainable agriculture strategies to control the pest minimizing the use of insecticides, soil erosion and production costs.

#9

TROPHIC STRUCTURE OF ANT COMMUNITIES IN CEREAL FALLOW LAND SUCCESSION. Serrano, J.M.; Acosta, F.J.; Gomá, J. & López, F. (Departamento de Ecología, Facultad de Biología, Universidad Complutense de Madrid, 28040 Madrid, Spain).

In this work we investigate the successional trends of ant communities from cereal fallow lands of Central Spain, according to the relative proportion of trophic groups (omnivores, nectarivores, granivores, and insectivores). A static successional sequence was made up using 8 plots with different abandonment age (time since last ploughing), from 1 to 40 years. Sequential arrays of pitfall traps (a total of 2000) were employed to collect ant workers. Sampling work was carried out in spring, summer, fall, and winter of 1983-84. More than 14000 individuals, distributed in 29 species, were found. The basic trends showed by the different trophic groups along succession were as follows: nectarivores in pioneer stages, insectivores and omnivores in intermediate stages, and granivores in mature stages. The trophic heterogeneity of the ant communities increases through succession.

#10

ECOLOGICAL SUCCESSION OF GRASSHOPPER COMMUNITY UNDER DIFFERENT GRAZING INTENSITIES

Kang Le and Chen Yonglin (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Vegetation, grasshopper density and species composition were monitered on the natural steppe from 1988-1989 in Inner Mongolia, China. The pastures sampled belong to 3 types of vegetation which were separately laid in 3 series of grazing succession. Each series consisted of 5 gradients of different grazing intensities. Along these gradiends, the species composition, population number and biomass of the grasshopers varied sensitively. To distinguish grasshopper's successive populations, the concepts of Neartude and Choosing Rules were used. By combining the Grey Relation with the Cluster Analysis, 11 grasshopper species were divided into 3 grazing ecological assemblages: increaser, decreaser and invader. The results from Correspondence Analysis and Factor Analysis proved that there were close successive relations among these assemblages, which varied with the plant species, biomass, height and coverage. The influence effect and reason in grazing on the grasshopper community were studied. The importance of some grasshopper indicators was also mentioned.

#11

TROPHIC NICHE OF THE STEPPE GRASSHOPPERS

Kang Le and Chen Yonglin (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Microscopic examination of crop contents was used to determine the food preferences of grasshoppers on the typical steppe in Inner Mongolia, China. Results from the dietary analysis of 11 species of grasshoppers showed that 31 vascular plant species, a species of fungus and mite served as food item. On the basis of their food resources, the grasshopper species were divided into 5 groups: graminvorous, mixed graminivorous, mixed forbivorous, forbivorous and phyto-carnivorous. The overlap, partition and width of the trophic niche among grasshopper species were studied by combining the methods of popular indices with the techniques of multivariate analysis. Authors proposed a new concept and method in measurements of potential and realized serious values of the grasshopper species based on their energy values, biomass and food habits. The concept and methods are very useful to evaluate the economic importance of grasshopper species in this region. The coexisted relationships among these grasshopper species within the ecosystem of typical steppe in Inner Mongolia were discussed.

#12

SPACE INVASION AND COMPETITION IN MEDITERRANEAN ANT COMMUNITIES DURING SUCCESSION. Serrano, J.M.; Acosta, F.J. & López, F. (Departamento de Ecología, Facultad de Biología, Universidad Complutense de Madrid, 28040 Madrid, Spain).

Several ant communities of fallow lands from Central Spain are studied in this work employing a static successional methodology. Several plots from three study sites (which constitute three successional sequences) with different abandonment age (time since last ploughing) and surrounding matrix (forests, uncultivated, and cultivated lands), were excavated. All the ant colonies found within each plot were identified, counted, and their extension mapped on a grid of squares. The space occupied by the ant colonies increases through the three successional sequences. The number of colonies increases significantly but they do not increase in size in the study sites surrounded by uncultivated or cultivated lands. The contrary occurs when the surrounding matrix is composed by forest (significant increase in size but not in number). Finally, those study sites having an expected higher information flux from the surrounding matrix (mosaic of uncultivated fields and forest) show a significant increase of the overlapping in space of neighboring colonies.

#13
DIPLOPODE ROLE IN THE DECOMPOSITION AND TRANSFORMATION OF FOREST LITTER IN THE SOUTH OF PRIAMURJE. G. N. Ganin (Institute of Water and Ecological Problems, Khabarovsk, Kim-Yu-Chen St., 65, 680063, Russia)

Nutrition activity and ecological efficiency were evaluated on the basis of six types of forest litter. Litter assimilation varies from 5% to 94%, correlating negatively with protein content in feed and positively with cellulose content. Feed efficiency for growth does not exceed 10%. Seasonal decomposition ability of diplopodes is 15-20g/m^2 that makes approximately 20% of litter decomposed by the entire complex of big saprophages. Diplopodes assimilate 50% of the material, 1/5 of this amount is transformed to the next trophic level. Middle-aged specimens assimilate daily 0.1mg of cellulose and 0.04mg of protein that equals to 20% and 10% of actual ration respectively.

#14
STUDY ON THE SPECIES STRUCTURE OF COMMUNITY AND ITS STABILITY IN PADDYFIELDS. Jin Cuixia, Wu Ya (Institute of plant protection, Jiangsu academy of agricultural sciences, Nanjing, 210014)

There are at least 560 arthropod species belonging to 18 orders and 151 families in paddyfields in the south of Jiangsu. Most of them consist of Hymenoptera,Diptera,Coleoptera and Hemiptera, and the last 2 orders include most phytophagous species. Predatory insects primarily are the members of Coleoptera and most parasites are Hymenoptera.There are three trophic levels in the community. Two food webs dealing with 8 species of Lepidoptera and 6 species of Hemiptera have been drawn separately. There are daily and seasonal dynamics in the species structure of community. To analyze the dynamics of species structure with Similarity Index J, the results showed that there were significant differences of daily dynamic in the numbers or compositions of species between the paddyfields of single crop rice and late rice of double crop rice.J values in the former were larger than those in the latter. The seasonal dynamics of the community structure were affected by several factors:(1) Cropping systems. J values in the area of single crop rice were larger than those in the mixed area of single crop rice and double crop rice, it meant that the community in the former area was more stable;;(2) Type and variety of rice. The community in middle japonica rice was more stable than that in crossing rice,and the same was true in single crop rice than in double late rice; (3) Insecticide.It made the community stability declining.

#15
GULF WAR IMPACT ON DESERT INSECTS OF KUWAIT. W. Al-Houty (Kuwait University, Faculty of Science, Zoology Department, P.O. Box 5969 Safat 13060, State of Kuwait)

The desert ecosystem in Kuwait suffered destruction due to burning of 950 oil wells which produced soot and many oil lakes of 15m. length and 10m. depth. The oil and soot covered the soil and vegetation of the desert. Destruction resulted also from digging tank bunkers of 6m. depth, soldiers trenches of 6m. depth and 2.5m. height, and from the moving of military vehicles which in turn contributed to plow the sand and disturb the under soil inhibitors. Hence, various desert insect species have been killed either during visiting oil lakes which look due to mirage as water lakes to dragon flies in the sky or during foraging for food plants by beetles. However, many sand termites and ants seemed to survive this ordeal as creatures that can store food in chambers under the soil away from soot or oil spills. Many termite mounts appear to scatter in the black sooted desert producing a fascinating mosaic white spots planted on black sand, desert ants seen running in an area near to burned oil fields.

#16
ENCYRTID COMPLEXES (CHALCIDOIDEA) IN PLANT COMMUNITIES OF THE CENTRAL-ASIAN DESERT KARAKUM. S.N.Myartseva (Institute of Zoology, Turkmenian Academy of Sciences, Ashkhabad, 744000, USSR).

In different landscapes of the Karakum 219 species of parasitic wasps of the family Encyrtidae were collected, from which 48,1% are attached to euxerophytical vegetation. In Haloxylon-Calligonum communities of sandy desert 27 species of encyrtid inhabit, of them 11 are only here. The encyrtid fauna on salty-marshes is similar in all types of deserts (10-11 species). On wormwoods in sandy desert 8 species and in stony desert 12 species live. Encyrtid complex on Tamarix is very poor in stony desert (4 species), is similar in sandy and salty deserts (10-11 species) and is various in tugai (forests in river's valleys) - 23 species. In tugai encyrtid fauna is various especially on long-gramineous plants (32 species). In oasises in gramineous -diversigrassy communities 13 species inhabit. Turan endemics compose 58,4% of fauna in sandy desert, 59% in salty desert, 49,1% in stony desert, 46,2% in tugai and only 27,3% in oasises.

#17
RELATIONSHIPS AMONG RICE YIELD AND ITS COMPONENT FACTORS UNDER THE CONDITION OF STEMBORER DAMAGE. Bin Chen, Weiwen Wu (Dept. of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

Path coefficient analysis and multiple linear regression analysis on relationships of four yield component factors to rice yield under the condition of naturally occurring and simulated stemborer damadges were carried out. The results showed that the sequence from large to small of these factors affecting the yield was effective ears per unit area, average grains per ear, percentage of plump grains and 1000-grain-weight, and the ear number had larger change, and 1000-grain-weight was comparably steady. Between the ear quantity and other three factors existed larger negative relation; between average grians per ear and percentage of plump grains or 1000-grian-weight existed considerable negative relation, and between the later two factors existed little relation. To some extent, if other three factors had no change, when they increased by 10,000 ears, 10 grains, 1% and 1g, respectively, the yield increased 28.7kg, 42.6kg, 5.9kg and 25.7kg, respectively.

#18
THE ECOLOGY OF THE STAPHYLINIDAE IN THE FORESTS OF WEST SIBERIA. A.S.Babenko (Biology & Biophysics Research Institute, Tomsk 634010, USSR)

The reseache was conducted in the forests of different types of West Siberian region. There are about 450 species of Staphylinides in all forests habitats at large. Most of this closely connected with forests litter. There are 65 species in all type of pine forests; 56 and 48 species in cedar and silver fir forests respectively. Most of the rove beetles have high activity during from May to October in the south part of West Siberia. All rove beetles are inactive in winter during period of snow cover.

#19

TROPHIC RELATIONS OF THE ARTHROPOD COMMUNITY IN PADDY FIELDS. You Minsheng (Dept. of Plant Protection, Fujian Agricultural College, Fuzhou 350002, China), Pang Xiongfei (Dept. of Plant Protection, South China Agricultural University, Guangzhou 530642, China)

This paper deals with the trophic structure and types of the arthropod community in paddy fields based on the data obtained from outdoor surveys and indoor experiments. In the ecosystem of paddy fields, complex food chains and food webs may be formed because of the interspecific relations of feeding, parasitism and predatism. According to the living patterns of the parasitic species in the food webs, the trophic structures of the arthropod community in the paddy fields of Fuzhou suburbs can be divided into three types: (1) no link of epiparasitism has been found in the food webs; (2) there are some links of epiparasitism in the food webs; and (3) there exist some links of double parasitism in the food webs. By using some of the knowledge and the operation rules of graph theory, a food web can not only be described as a signed directed graph (SDG), a set, or an adjacent matrix, but also be combined with others. The method has been proved valuable in the studies of trophic relations of a complex community.

#20

A STUDY ON THE FOOD HABIT OF ERICERUS PELA CHAVANNES. Chang-hai Zhang, Hua-qin Liu, Jin Cai (Resources Insect Institute of Chinese Academy of Forestry, Kunming 650216, China)

Concerning the food habit of Ericerus pela Chavannes, specialists and researchers at home and abroad believe it is a limited or oligaphagous feeder. However, on the basis of the past researches done by other scientists in this field, we have done further researches on it in the white wax production areas in China and found out this is not true. Our investigations have revealed that E. pela lives on 42 species of host plants which belong to 9 genus of 6 families: Ligustrum, Fraxinus, Syringa and Chionanthus of Oleaceae; Castanopsis of Fagaceae; Hibiscus of Malvaceae; Vitex of Verbenaceae; Rhus of Anacardiaceae and Ilex of Aquifoliaceae, According to this result, we think E. pela to be a generalized or euryphagous feeder. The application of the term oligophagy to it is not resonable and should be corrected. As a scientific breakthrough, our discovery is of great significance to the development of white wax production in China.

#21

HABITAT SELECTION IN EUPHYDRYAS AURINIA (LEP. NYMPHALIDAE): OVIPOSITION PREFERENCES AND FLIGHT AREAS. J. Martin, M.L. Munguira, E. Garcia-Barros & J.L. Viejo. Dep. Biología, Univ. Autónoma de Madrid, E-28049 MADRID, SPAIN.

Euphydryas aurinia is a single brooded nymphalid widespread in the Paleartic. During the last decades population numbers have declined and the species has vanished from former habitats and the species has been considered endangered.

The results of a population study In the Center of the Iberian Peninsula show that adults prefer open woodlands and clearings, provided they have enough suitable flowers to feed. Oviposition takes place on the leaves of honeysuckle (Lonicera periclymenum), the larval foodplant. As the plant creeps over oak trees in the woodland canopy, oviposition and larval development takes place in covered areas.

Our data clearly show that traditional land uses such as extensive grazing and charcoal production have a positive effect on population numbers. The reason for this is the mosaic of grasslands and woodlands favoured by this management practices, that match perfectly with the habitat preferences of E. aurinia in our area.

#22

CO-PHENOLOGY OF GENISTEAE (LEGUMINOSAE) AND PHYTOPHAGOUS COLEOPTERA IN MOUNTAIN SYSTEMS OF CENTRAL SPAIN (S.W. EUROPE). P. GURREA; M.J. SANZ & A. GARCIA-OCEJO. Dep. Biología. Univ. Autónoma de Madrid. E-28049 MADRID. SPAIN.

In this paper we establish the different patterns of larval and adult behaviour of phytophagous Coleoptera (Curclionoidea and Chrysomelidae) that have been observed in seven Genisteae shrubs in the Iberian Peninsula (Sistema Central)· studied between the years 1985-1990.
To compare insect phenologhy with host-plant phenplogy we have found five clearly different relationships:
A) Winter-spring species: Eating leaves and stems;
B) Spring species: These appear in the peak of the flowering season;
C) Spring-aestival species: Appearing in the fruit season;
D) Aestival species: They are fruit and root-feeders;
E) Aestival-autumnal species: In this group adults are defoliators.

#23

GALL-MIDGES (DIPTERA, CECIDOMYIIDAE) ON THE ARBORESCENT-SHRUB PLANTS IN KAZAKHSTAN. Z.A.Fedotova (Inst. Zool. Kazakh Academy of Science, Academgorodok, Alma-Ata, 480032, USSR).

231 gall-midges species from 39 genera and 4 tribes were noted. They damage 124 species of arborescent-shrub plarts, belonging to 38 genera from 19 families. 98 species of plants are dominants of vegetation. The largest number of species were found on Chenopodiaceae (138), Tamaricaceae (24) and Fabaceae (23). Monophagous were found only on Betula, Calophaca, Ceratoides, Convolvulus, Cotoneaster, Elaeagnus Ephedra, Halostachis, Hammada, Hulthemia, Juniperus, Pentaphylloides, Ribes, Spiraeanthus. The other species are narrow oligophagous, which damage their fodder plants together with complex of other such spicies. The most large complex of other such species. The most large complex is on Haloxylon (45 species), Salsola (32), Salix (22), Tamarix (18), Caragana (7). In the desert area 135 species were noted, in mountains - 82. Specific (220) with respect to arborescent-shrub plants are the following genera: Etsuhoa, Desertomyia, Kaltenbachiola, Massalongia, Psectrosema, Tricholaba, Xerephedromyia. Among rare plants gall-midges damage Calophaca soongorica (5 species), Salsola chiwensis (3), Spiraeanthus schrenkianus (1), Atraphaxis muschketowii (1). 152 species are relative endemics.

#24

INFESTATION PROCESS OF *Scirtothrips dorsalis* Hood, ON CITRUS IN RELATION TO HOST PREFERENCE AND MIGRATION. Nobuo Ohkubo (Nagasaki Fruit Tree Experiment Station, Omura, Nagasaki Pref. Japan 856-01)

In Japan, yellow tea thrips, *Scirtothrips dorsalis* Hood, has caused serious damage on fruits and young shoots of various fruit trees, especially citrus, grape and persimmon, etc, since 1967. Damage of fruit tree by thrips is almost cosmetic or external, not injurious to growth of tree or internal quality of fruit. The abundance of population and degree of damage on fruit trees are depended on the occurrence pattern of young shoots which are suitable places for reproduction, and the immigration of adults from other host plants, especially tea, longleaf podocarpe or viburnum that is crop or wind-break fence tree around orchards, for the reason that this thrips has over 100 species of host plants, including crops. Adults prefer young shoots of podocarpe and citrus more than citrus fruits. Therefore citrus fruit damage mainly occurrs during the 2nd generation, i.e. the middle of June, and the 4~5 generation, i.e. the end of August to the first part of September in which adults invade to orchards, because there are few young shoots for suitable food. On podocarpe, the most important plant for reproduction of *Scirtothrips dorsalis*, another species of thrips, *Oxythrips* sp also lives. When the popuation density of one species is high, another is low, on account of competition for food in larval stage between these two species.

#25
THE ROLE OF HOVER FLIES (DIPTERA: SYRPHIDAE) IN POLLEN TRANSPORT. Smiljka Simic, Predrag Radisic (Institute of Biology, Novi Sad, Novi Sad 21000 Yugoslavia)

The application of pollen analysis method in insects research is of complex importance, espeeially when the subjeet is a group of insects (Syrphidae) known as good pollinators of many plant species. In investigation of pollinating aetivity, species *Cheilosia grossa* (Fallen, 1817) was used as a model. This species is distributed in West Palearctic, and belongs to early spring species group. It habitats areas with marsh and forest vegetation.

For collecting and preparation of pollen original methods were used. After analysis of qualitative and quantitative composition of pollen, importance and place of investigated species in ecosystems was established.

#26
EFFECT OF CANNIBALISM ON LOW POPULATION DENSITY OF A PREDATORY MOSQUITO, Toxorhynchites towadensis.
Yasuda, H., Kurihara, M., Mitsui, T. (Insect Toxicology & Physiology, RIKEN, Wako, Saitama 351-01, JAPAN)

Toxorhynchites towadensis is a predatory mosquito. This species is beneficial to man because the larvae eat other mosquito larvae, however, the adults none feed on blood.

Laboratory experiments were carried out to investigate the importance of cannibalism as well as oviposition site selection in Tx. towadensis. The females of this species laid many eggs in one pot, and showed a no preference for pots containing the prey larvae, Aedes albopictus, over pots with conspecific larvae. The vulnerability to cannibalism was high for small individuals and starvation promoted the cannibalism. Although there were a lot of individuals of the prey larva in a pot, Tx. towadensis ate conspecific larvae. These data suggest that the cannibalism is common in Tx. towadensis.

One reason why Tx. towadensis is low population density may be caused by the cannibalism.

#27
EFFECTS OF HELIOTHIS ARMIGERA AT THE SECOND GENERATION ON COTTON FRUIT-SETTING AND YIELD. Shao-gui Wen, Yu-qin Yang, Chang-yuan Fang, Fa-qing Hu (Cotton Research Institute, Chinese Academy of Agric. Sci., Anyang, Henan 455112, China)

The damage to cotton square-flowers was studied through artificial infestation using the Heliothis armigera larvae at the second generation and simultaneous removal of the corresponding reproductive organs in the caged plots with soil fertility at medium-level during 1988-89 so as to determine the compensation period and function to those injured organs. The data of 240 fruiting branches in 20 plants observed on July 17 and September 10 were used to analyze the fruit-setting patterns. The results show that the number of fruits at the first to second nodes in all treated plots was lower than in the control, while that at the third to fifth was much higher than in the control with the differences between two highly significant demonstrated through t-test. Compared to the control, seed cotton yield increased by 4-5% in the plots with all squares at the first to third fruiting branches or 8 squares per plant removed but decreased by 17% in the plots infested with one single larva per plant.

#28
FLIGHT BEHAVIOR OF BLACK CUTWORM (AGROTIS YPSILON) MOTHS. Yazhong Cao (Institute of Plant Protection, CAAS, Beijing 100094, China)

Adult flight activities of Agrotis ypsilon (Rot.) were observed on flight mill. Results from the observations showed that the flight activities were intermittent. The persistent flight generally lasted more than 8 hr. with the longest record of 40 hr., and the resting period between two persistent flights varied from 5 to 45 min. Flying speed during the flight process demonstrated a waveform variation. The moths usually changed their flight speeds after a 10 to 30 min. uniform flight. At night, the most active flights at the first 2 hr. (7:00-9:00 p. m.) and gradually reduced their speed up to the midnight. However, most of fliers showed a second peak of high-speed flight at dawn. Flying speed of the moths tested ranged from 1.5 to 2.5 m/s with the highest speed of 5.6 m/s. Further studies elucidated that variations in black cutworm flight behavior were closely correlated to the developmental status and hungry intensity of moths, and that the environmental factors affecting black cutworm flight activities were temperature, relative humidity and light intensity, etc.

#29
A NEW METHOD TO EVALUATE COEFFICIENT OF PREDATION. Liu-zhu Nan(Plant Protection Institute Of Hebei Aedemy of Agriculture and Forestry,Baoding 071000, China)

A new formula is put foreward in the present paper to express and evaluate the selective predation of natural enemies on their preys in the situation of coexistence of one predator with more than one species of preys.

$$ci = \frac{Nai \cdot \sum Ni}{\sum Nai \cdot Ni}$$

Ci: selective coefficient to one prey.

Ni: number of one prey.

$\sum$ Ni: total number of preys.

Nai: captured number of one prey.

$\sum$ Nai: total captured number of preys.

This new formula was checked with practical data and the results were as follow: when Erigonidium graminicola, a predatory spider, coexist with cotton aphids, Aphis gossyppi and eggs of cotton boll worm, Heliothis armigera, C1(aphids) = 1.1428, C2(eggs of boll worm) = 0.8562. when this spider coexist with cotton aphids, eggs and 1st inster-larvae of cotton boll worm, C1 (aphids) = 0.6780, C2(eggs of boll worm) = 0, C3(larvae of boll worm) = 2.5001.

#30
HELET, A SIMULATION MODEL FOR HELIOTHIS ECONOMIC THRESHOLD IN COTTON. C. F. Sheng (Institute of Zoology, Academia Sinica, Beijing 100080, China). K. R. Hopper (European Parasite Lab. ARS, USDA, 13-17 rue de la Masse, 78910 Orgerus-Behoust, France)

HELET, a simulation model with an intermediate complexity for HELiothis Economic Threshold is presented. In the cotton plant submodel, the crop yield history was employed to adjust the growth parameter created by Hearn & Da Roza (1985) and the soil water stress was included. This submodel can well simulate the responses of cotton plant to the fruit loss under various conditions, especially the over-compensation for the early square loss on rich and midium fertility soils. For the second generation bollworm in North China, the simulated economic thresholds were 276, 106, and 67 in eggs cumulated for a generation per 100 plants averaging over four growing seasons on the rich, midium, and poor soil, respectively. Eggs of 52, 37, and 28 are simulated for the third generation at the three levels of soil fertility. These are generally accordant with the thresholds derived from the observed data.

#31

MATHEMATICAL MODELING OF THE PREDATOR-VICTIM RELATION IN EGGPLANT. **Antonia Mateeva Radeva, Nicola Nicolov Radev** (I2I Rouski Avenue, 4000 Plovdiv, Bulgaria)

The Colorado potato beetle (CPB) *Leptinotarsa decemlineata* (Say) is the single most destructive pest of potato and eggplant in our country. There are several parasites and predators of this pest in Bulgaria. The elucidation of the relation between the Colorado beetle-*L. decemlineata* Say and *Coccinella septempunctata* L. is of interest as an element in the integrated plant protection in eggplant. As a result of this study made, the most appropriate parameters of interaction have been established with different technological of cultivation. Regression equations have been worked out giving the change in the insect density as depending on the climatic and agrotechnical factors. Besides it was established that the *C. septempunctata* L. is very important predator of other pests by eggplant.

#32

INTEGRAL OR MULTIPLE DEFENSE SYSTEM (IMDES) OF PLANTS AGAINST HERBIVORES. Tae-Toung Moon (Korean Entomological Institute, c/o Korea University, Seoul 136-701, Korea)

Plants have developed various defense-mechanisms to protect themselves from herbivorous insects which also evolved various strategies to overcome the defense-mechanisms of plants. The physical, adaptive, chemical and biotic defenses are respectively investigated with particular interests on the seed/pods of common vetch *Vicia sativa* L. in Britain, United States and Korea; physical defense - the seeds are protected by their pods from generalist-insects since early developmental stages; adaptive defense - the mother-plants choose the best habitats for seeds to survive. The survived seeds mature quickly in a short period and then were released immediately to the ground; chemical defense - the seeds contain various secondary substances like cyanoglucoside vicianin, amino acid β-cyanoalanine and lectins that all may be toxic to herbivores; biotic defense - seed/pods are directly guarded by resident ants that are initially attracted by extrafloral nectaries and also take advatages of hostility on herbivores by parasitoids and predators visiting the plants. However, there are several sets of evidence that it is not quite effectve for plants to equip with "a single defense mechanism (ASDEM)" to protect themselves against overall herbivores which evolve fastly their coadaptive abilities, particularly when some insects already overcome ASDEM. "The integral or multiple defense system (IMDES)" combining physical, adaptive, chemical and biotic defenses may be an ultimate defense strategy, so far, devised by the plants under historical attack of herbivorous insects.

#33

THE INFLUENCE OF BERMUDAGRASS ALLELOCHEMICALS ON SPODOPTERA FRUGIPERDA HERBIVORY. Quisenberry, S. S. (Department of Plant, Soil and Entomological Sciences University of Idaho, Moscow, Idaho USA), M.A. Mohamed (Department of Entomology, Louisiana State University Baton Rouge, Louisiana USA)

Bermudagrass (Cynodon dactyon L. Pers.) cultivars resistant to the fall armyworm (Spodoptera frugiperda [J. E. Smith]) have been identified. A research program was initiated to define bermudagrass allelochemistry with respect to insect herbivory. Fall armyworm is variably responsive to bermudagrass cultivars and somaclones. The basis of this variability is causally related to a differential concentration of the phagostimulant 6,10,14 trimethylpentadeca-2-one. The nutritional suitability of bermudagrass to herbivory was cultivar dependent and associated with a variable profile of several essential dietary lipid components. These included polyunsaturated fatty acid esters, vitamin E, and the sterols campestrol, stigmasterol, and sitosterol. A differential accumulation of an antifeedant, 3,7,11,15-tetramethyl-2-trans-hexadecen-1-01, was found to vary between susceptible and resistant cultivars and somaclones. The cultivar dependent variability of allelochemicals will enable an **in vitro** based schema with molecular predictors for the selection of insect resistant bermudagrass.

#34

WHEAT RESISTANCE TO DIURAPHIS NOXIA AND EFFECTS OF PRECONDITIONING HOST PLANTS. C. M. Smith[2], Schotzko, D. J.[1], R. S. Zemetra[1], E. J. Souza[1], S. S. Quisenberry[1]. ([1]Department Plant, Soil & Entomological Sciences, University of Idaho, Moscow, Idaho USA. [2]Department of Entomology, Kansas State University, Manhattan, Kansas USA).

The Russian wheat aphid, Diuraphis noxia (Mordvilko), causes serious damage to wheat and barley in Asia, Africa, South America, Mexico, and the United States. Of the 280 wheat cultivars and breeding lines evaluated, the breeding lines ID 0367, ID 0415 and TXGH 10989, the cultivar 'Treasure', and the plant introductions PI 137739, PI 262660, PI 294994, PI 47545, PI 94355, PI 94365, PI 94460, and PI 151918 were identified as resistant to D. noxia. The breeding lines and 'Treasure' showed a low level of resistance, PI 262660 and PI 94460 were intermediately resistant, and PI 137739, PI 294994, PI 47545, PI 94355, PI 94365, and PI 151918 were highly resistant to D. noxia. PI 137739, PI 262660, PI 294994, and ID 0367 were evaluated to determine categories of D. noxia resistance. All entries showed tolerance to aphid feeding. In addition, the three plant introductions displayed antibiosis to aphid reproduction. The preconditioning host of D. noxia is crucial for assessment of aphid responses and test plants. Attention to preconditioning of aphids is of importance if resistance categories are to be effectively determined.

#35

THE INFLUENCE OF PREDATING QUANTITY OF ANT-LION ON ITS INDIVIDUAL DEVELOPMENT. Xuan-da Zhang, Han-hui Zhou, De-xiang Gu (Research Institute of Entomology, Zhongshan University, Guangzhou 510275, China)

This paper reports firstly the success of ant-lion oviposition under the artificial feeding conditions in laboratory. The results showed that developmental period of ant-lion larvae shortened with the increasing of predate probability, and the development of larvae population became more uniform in feeding once a day than that in feeding once a week. The average development time of ant-lions which predated every day decreased by 43.4% compared with the case of that predated once a week. The result also indicated that the ant-lion could complete 3 generations in a year under the experimental conditions (a life cycle would take the least one in nature).

In the experimental condition enough prey was provided artificially. In order to test the unnecessity of the low temperature and short photo-period, the condition of 25°C temperature and 14 hours light was used to substitute the low temperature and short photo-period in winter (from November to March of next year). It showed that the food was the most important factor which influenced the ant-lion development.

#36

THE INFLUENCE OF SPIDER MITE /TETRANYCHUS URTICAE KOCH/ FEEDING ON ACTIVITY OF POLYPHENOLOXIDASE /PPO/ AND PEROXIDASE /POD/ IN CUCUMBER. Tomczyk Anna/ Department of Applied Entomology, Warsaw Agricultural University, 02-766 Warsaw, Nowoursynowska 166, Poland

Two cultivars of 5 week old cucumber plants were infested with spider mites. After 3 and 6 days of spider mite feeding activity of phenolases: PPO and POD was studied.

It was found that very soon after infestation the activity of both enzymes increased. Activity of POD in damaged cucumber leaves, in relation to undamaged, increased more than the activity of PPO. The differences in the responce between studied varieties of cucumber were observed.

#37

SEED PREDATION BY INSECTS ON A WOODY PERENNIAL PLANT, Cistus ladanifer L. Acosta, F.J.; Serrano, J.M.; Pastor, C. & López, F. (Departamento de Ecología, Facultad de Biología, Universidad Complutense de Madrid, 28040 Madrid, Spain).

Cistus ladanifer L. is a woody perennial plant distributed throughout the western mediterranean region. The seeds produced by this plant are kept within lignified globular capsules (fruits) splitted up in compartments (constituted by contiguous valvae). Before the valvae of the fruits open and the seeds are liberated for new seedling establishment, they remain inside the fruits during a period of several weeks. This interval of time is critical, because some insect species are able to drill the capsules and predate on the seeds. We have studied the sequential invasion and predation rates by insects on the seeds of a natural population of Cistus ladanifer L., from the moment of the production of fruits until their final opening. A special attention is payed to the influence of the fruit compartments on predation, since they could also act as barriers (they have also to be drilled) to the spreading of the infection from the initial compartment invaded.

#38

DIEL ACTIVITY AND SPATIAL PREFERENCES OF DUNG AND CARRION BEETLES (COLEOPTERA: SCARABAEIDAE) IN THE TROPICAL RAIN FOREST OF LOS TUXTLAS, MEXICO. M. E. Favila and A. Diaz-Rojas. Instituto de Ecología, Apartado Postal 63, Km. 2.5 Antigua Carretera a Coatepec 91000 Xalapa, Ver. México.

We compared the changes in diel activity of dung and carrion beetles of the Scarabaeinae subfamily during their period of maximum activity (June to September of 1990) in three different microenvironments in the rain forest of Los Tuxtlas, Mexico: Within the forest, on an edge and in a gap in the forest. Twenty nine species coexist in the rain forest; 12 species are nocturnal, 10 species are diurnal, and 7 species are active at night and during the day. Diurnal species had clear preferences for each microenvironment. Canthon (G.) femoralis was the most abundant species within the forest; Canthon (G.) virids dominated in the gap, and Canthon cyanellus cyanellus on the edge. This last species is also found in the pastures of the region of los Tuxtlas. The abundance and diurnal activity of Scarabaeinae beetles were different in each microenvironment and both changed with the season. In general, during the last month (September) abundance decreased and the diurnal beetles began their activity later in the morning than in the preceding months.

#39

STUDIES ON POPULATION DENSITY AND SECRETION OF LAC INSECT , KERRIA LACCA (KERR.). Xiao-ming Chen, Ying Feng (Insect Resource Institute, Chinese Academy of Forestry, Kunming 650216, China)

The population density and secretion of lac insect in winter and summer generations have been studied in this paper. The research results have shown that the secretion of female adult is about 95% of total secretion, the secretion of larvae is very little, the population density of female adult late period in winter and summer generations, 20-30 bodies/cm^2 , is favourable for secretion . In winter generation, the highest secretion of lac insect parasitized Dalbergia balansae Prain is about 10.60 mg/♀ , and population density is 25 bodies/cm ; in summer generation, the highest secretion is about 15.64 mg/♀ , and density is 27 bodies/cm^2. Lac insect soomthly secret in winter generation and flourishingly secret in summer generation. In summer generation, there is a high secretion period in female pregnant 3-4 stages, population density is 35-40 bodies/cm^2. Other biological characters of lac insect have been also discussed in this paper.

#40

ENERGY FLOW THROUGH THE GRASSHOPPER CHORTHIPPUS DUBIUS (ZUB.) POPULATIONS IN THREE DIFFERENT PLANT COMMUNITIES IN INNER MONGOLIA GRASSLAND ECOSYSTEM. Xing-hui Qiu, Hong-chang Li (Institute of zoology, Academia Sinica, Beijing 100080, China)

Chorthippus dubius (zub.) is a dominant species of grasshopper in northwestern pasture of China. The present paper deals with the energy flow through the grasshopper populations in three different plant communities representing different degree of degradation in Inner Mongolia grassland. Results indicated that the amount of energy consumed and assimilated from the net production of aboveground vegetation was of the order of 0.21-1.03% consumed and 0.1-0.59% assimilated. An additional 0.21-1.93% of this production were cut and dropped by the grasshopper populations. Approximately 0.03-0.06% of the energy of net aboveground primary production were converted by the grasshopper populations into body and were available to higher trophic levels.

By comparison, the grasshopper population in the most degraded plant community had the strongest grazing pressure on the pasture, but the population in recovery plant community had the hightest net production. Similar efficiencies were found among the Chorthippus dubius populations in these three different communities i.e. growth efficiency (P/A), 30-32%; ecological efficiency(P/C), 14-18% and assimilation efficiency(A/C) 48-58%.

#41

A PRELIMINARY STUDY ON THE SURVIVAL ANALYSIS OF LIPAPHIS ERYSIMI KALT. Hong-bin Wang, Zhi-he Guan (Research Insititute of Forestry, Chinese Academy of Forestry, Beijing 100091, China)

The effects of different densities of Lipaphis erysimi at different tempratures on the nymphal age were observed with group-tracking method, and the theory of survival analysis was applied to the study of molting time. According to the multistate survival analysis of the L. erysimi, the life table of the nymphs in the labratory was set up, and with the function of the statistic variables introduced.

#42

A SAWFLY *STRONGYLOGASTER OSMUNDAE* (HYMENOPTERA: TENTHREDINIDAE) REGULATES PHENOLOGY OF ITS HOST FERN. Kimio OTSUKA (Dept. Zool. Fac. Sci. Kyoto Univ. Kitashirakawa, Sakyo, Kyoto, 606 JAPAN)

Voltinism and host plant utilization of a sawfly *Strongylogaster osmundae* were investigated. This species was multivoltine (5 or 6 generations per year) and emerged from late April to July or early August in Kyoto, Japan. Female sawflies deposited eggs on new leaves of an osmund fern, *Osmunda japonica*, and larvae fed on them. The host plant usually developed new leaves from late April to early May (primary shoots), and intact ferns rarely shot new leaves thereafter. As primary shoots were new and available to the sawfly until the beginning of June at latest, only the first and second generations could utilize them. The eggs were laid in clusters, and the larvae fed gregariously and frequently defoliated leaves. The defoliation by the first and second generations induced the fern's compensatory regrowth, which produces food resource of the third and subsequent generations. Therefore, egg clumping and defoliation by *S. osmundae* is a kind of host regulation to maintain its multivoltine life history. The effect of this interaction on *O. japonica* (mutualism or simple parasitism) is also discussed.

#43

PHOTOPERIODIC INDUCTION OF LARVAL DIAPAUSE AND LOW-TEMPERATURE CAUSING REPRODUCTIVE INACTIVITY IN A WILD BEAN BEETLE, *KYTORHINUS SHARPIANUS*

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A wild bean beetle, *K. sharpianus* shares most characteristics of storage species; multivoltine, oviposition on dry pods and seeds, and oviposition without feeding (Shimada, 1988). However, *K. sharpianus* adults which emerged from overwintered larvae show reproductive inactivity (Shimada, 1988). It also enters larval diapause at the 4th instar under a short day length (Shimada & Ishihara, 1991).

In the present paper, we investigated their diapause features in detail. The critical photolength of diapause induction was 14.5L-9.5D at 24 °C, and sensitive stages of the day length were from 3rd to 4th instars. Larval diapause was terminated not only with elongating the day length but also with shifting temperature higher after chilling without changing day length. However, the larval experience of chilling caused emerging adults to be reproductively inactive as a post diapause effect. These adults recovered reproductive ability if they were fed.

It is the first evidence in bruchidae that the larval diapause is induced and terminated with controlling the day length.

#44

WITHIN-POPULATION VARIATION IN DEMOGRAPHY OF THE HERBIVOROUS LADY BEETLE. Takayuki Ohgushi (Faculty of Agriculture, Shiga Prefectural Junior College, Nishi-shibukawa 2, Kusatsu, Shiga 525, Japan)

I investigated cohort demography within populations of the thistle-feeding lady beetle Epilachna niponica. In particular, I focus on how demography varies from one cohort to another, by comparing life tables for cohorts produced over a season. Data are based on mark-recapture experiments for >9000 adult beetles and life table statistics over five years at two localities. Survivorship-curves differed significantly among different cohorts within the populations. The among-cohort variation in demography was much larger than among-population variation in the same year. The major causes of these within-population differences were seasonal variation in intensity of egg and larval mortalities due to arthropod predation and host plant deterioration. This study emphasizes that no cohort has the identical demography with an averaged demography of population. Thus, we should take much attention to a within-population variation in demography to substantially understand population dynamics in insect herbivores.

#45

TEMPORAL AND SPATIAL DISTRIBUTION OF CALOSOMA BEETLES IN RELATION TO BEECH CATERPILLAR POPULATION. Naoto Kamata*, Yutaka Igarashi (Tohoku Res. Ctr., For. & For. Prod. Res. Inst., Shimokuriyagawa, Morioka, Iwate 02001, Japan)

The carabid beetle, *Calosoma maximowiczi*, is a conspicuous predator of the beech caterpillar, *Quadricalcarifera punctatella*. The beetle lives mainly in beech forests and attacks a variety of caterpillar species, but is most often seen where beech caterpillar populations are high, especially during the years of outbreak. Adult beetles feed on the caterpillar larvae, and immature ones feed on larvae and pupae of the caterpillar. Temporal and spatial distribution of the beetle in relation to beech caterpillar population were investigated in 7 plots located at least 2 km apart from each other. Seasonal occurrence of the adult beetles and the last instar larvae of the caterpillar corresponded, namely they both occurred from late July to mid-August. The beetles feed and reproduce, so that the densities of adult beetles and its larvae were highly related among plots. In increasing periods, the density of adult beetles had high relationships with the caterpillar density in the previous and the current year consequently. These processes usually generate a time-lag in a prey-predator system. However the beetles decreased as soon as the caterpillar population decreased, and no time-lag was recognized in this caterpillar-beetle system. The beetles could respond immediately to the prey density in both increasing and decreasing periods, so that the temporal and spatial distribution of the beetle was highly related with prey abundance without time delay. Reproduction and flight migration must cause such instantaneous numerical responses. Furthermore, there remains the possibility that adult beetles stay in the ground when the prey densities are low as reported for some species of other carabid beetles.

#46

RELATIONSHIP BETWEEN SEASONAL POPULATION FLUCTUATION AND NUMBER OF CATCHES BY YELLOW STICKY TRAP OF THE CHILLIE THRIPS, SCIRTOTHRIPS DORSALIS (THYSANOPTERA : THRIPIDAE) ON GRAPE. Manabu SHIBAO (Osaka Prefectural Agricultural and Forestry Research Center, Habikino, Osaka 583, Japan.)

The chillie thrips, Scirtothrips dorsalis, is an important pest insect of fruit trees, e.g. grape, citrus, persimmon. Seasonal population fluctuation and number of catches by yellow sticky trap of S. dorsalis were investigated on Neo Muscat from 1988 to 1990. Two experimental plots, lateral shoots cut off from shoots or not, were designed in 1989 and 1990. Number of S. dorsalis on shoots and flying adults was counted weekly by washing method with alcohol or cleanser solution and by yellow sticky traps respectively.

The infestation occurred from May to October and two peaks in density of adult and larva were detected in middle July and August. The seasonal change in number of catches was positively correlated with the density of adult on shoot. Therefore, the number of catches can be used for a rough estimation of the seasonal population fluctuation. The number of catches was different between the two experimental plots. It suggests that the number of catches is influenced by the quantity of usable resource (lateral shoot).

#47

POPULATION DYNAMICS OF THE EUONYMUS GALL MIDGE MASAKIMYIA PUSTULAE YUKAWA ET SUNOSE.

Tsukasa Sunose (Urawa Gakuin, Daiyama 172, Urawa, Saitama, Japan)

Yearly population fluctuations of Masakimyia pustulae were investigated at 19 sites in Kyushu. In sites where a platygastrid is the only parasitoid of the midge, the percentage parasitism was very low in the incipient stage of the outbreak of the midge populations. After the number of midges reached a peak, the midge populations declined as the percentage parasitism increased, and then the outbreak ceased. On the other hand, in several populations no outbreak was found and the percentage parasitism was constantly at a high level. Therefore, the immediate cause for the outbreak seemed to be a decline of the percentage parasitism. Like the midge, the platygastrid has one generation each year, and its females also emerge in spring to deposit their eggs within host eggs. The decline of the percentage parasitism seemed to be mainly affected by the time lag between emergence periods of M. pustulae and the platygastrid.

#48

RECENT ADVANCES IN RESEARCH ON MIGRATION AND PREDICTION OF RICE PEST NILAPARVATA LUGENS (STAL) IN CHINA. Xia-nian Cheng, Hai-kou Wang, Bao-hua Zhou (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China).

The brown planthopper (BPH) migrates northward 4-5 times a year. Mass migration of macropterous adults is synchronised with the approaching maturity of rice in infested areas. Continual south-west wind favoures northward migrations in Spring and Summer. Eight outbreak regions are identified in China. A schematic diagram was presented showing the hypothetical pathways of the seasonal migrations of BPH. The study in recent years, using a high frequency (8 mm wavelength) radar and a net suspended from a kytoon, confirms that long distance return migrations occurs in the area of Nanjing in mid and late September, with BPH being carried on the prevailing north-easterly wind towards the autumn infestation and overwintering areas of the species. The results show that after mass take-off in the late afternoon or dusk, the migrants fly for several hours during the evening, and often form a dense layer at heights between about 400-1000m above ground. These layers often have well-defined ceilings corresponding to an air temperature of about 16°C. The authors also collected a vast amount of population dynamic data in different localities obtained by light traps and field surveys and analysed the BPH immigrations in June and July from 1978 to 1983 at some sites in the Yangtze Delta by a numerical trajectory analysis scheme to estimate the pathways of BPH transportation in the lowest atomosphere (ca 1500 m). The models were run at height of 1500 m by using radio sounding data at 850hpa isobaric level under 7 time parameter matches to identify the possible sources of the BPH. The trajectory analysis strongly supports the hypothesis for the pathway of BPH migration in eastern China. These studies also are the modelling basis of mid-longterm prediction for BPH.

#49

LANDING PLACES OF MIGRATORY PLANTHOPPERS AND RICE LEAFROLLER ON THE EFFECT OF MEDIUM-SMALL SCALE ATOMOSPHERIC CIRCULATION AND ITS CONTROL STRATEGY. Miao Hu (Plant Protection Station, Ganyu 222100, Jiangsu, China), Xia-nian Cheng (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China), Ming-chang Gao (Central Forecast Station of Insect Pests and Plant Diseases, Wuhu 241000, Anhui, China), Zhen-qian Cao (Plant Protection Station, Wuxi 214000, Jiangsu, China)

Researches in some places of Jiangsu, Zhejiang and Anhui provinces show that immigrants of Sogatella furcifera (Horvath), Nilaparvata lugens (Stal) and Cnaphalocrosis medinalis (Guenec) land much more under the effect of atomospheric circulation in certain areas along the coast (e.g. the Yellow Sea and the East China Sea), rivers (e.g. the Yangtze River and the Qiangtang River), lakes (e.g. Taihu Lake), reservoirs (e.g. the Tashan Reservoir) and mountain valleys (e.g. the Jiuhua Mount). In these areas, immigrant peak appear earlier and more. The field population density is higher and damage is more serious. Because geographical positions of these areas remain stable, so does the medium-small scale atomospheric circulation, the landing and distribution pattern of migratory insects also do not have big changes. So we can set up pest observation points in these areas and put stress on mass landing areas to control the immigrants before its reproduction and destruction. In other vast areas with lower insect density, only those fields which may cause damage are controlled. Thus the blindness in forecast and control can be overcome. The acreage and times of control can be reduced, which results in great ecnomic, environmental, ecological and social benifits.

#50

ON FACTORS INFLUENCING THE POPULATION DENSITY CHANGES ON INDIAN MEAL MOTH. Jingyuan Xuan, Lunshu Li (Department of Plant Protection, Southwest Agricultural University,Chongqing 630716, China)

1. Temperature. The population of the first generntion developed in early June to mid July was at a low peak. Adults of the second generation developed in mid July to mid August and those of the third generation developed in late August to late September were both at a high peak, their mating rate. Might be as high as 95% at 26-30℃. In early October to mid November, adults of a low peak of fourth generation could be seen, if some larvae from the third generation adult developed early.

2. Food. Adult females always inclined to lay their eggs in large amounts on dried grape and rice grain, followed kernel wainut. survival rate and repoduction capacity of individuals fed on the preferred food were higher than those on chili or others.

3. Natural enemy. Larvae were attacked by the parasitic, Bracon hebetor with a parasitised percentage of ca. 14% in the spring and 9-25% in summer and autumn. A dead host's body migth send out 2-7 or more parasite larvae. In late October, adults of the parasite began to overwinter in stored foods of in houses. A high peak of the parasite adult could be seen in late July to late September.

4. Survival rate of the first generation. For the present experimented population, the highest one was 30. 82% under the conditions of influencing temperature, food and natural enemy.

#51

FORECASTING THE STAGE OF POPULATION DYNAMICS OF *EURYGASTER INTEGRICEPS* PUT, ON THE BASIS OF HYDROMETEROLOGICAL PREDICTORS. G. M. Doronina (Institute for Plant Protection, St.-Petersburgh, Pushkin 189620, Russia).

An agroclimatic approach to forecasting the stages of population dynamics of *Eurygaster integriceps* Put, has been developed permitting larval development and damage to winter wheat crops to be predicted on the basis of weather conditions during the critical period of the pest life cycle. The variables for the algorithm of long-term forecast are data on the initial state of a population (area infested by overwintered bugs and larvae, their numbers, egg parasitism of Telenominae, coefficient of fertility) and weather conditions (average temperature or the period from egg hatching to adult emergence and hydrothermal ratio during estivation). The stage of a pest population dynamics after hibernation can be determined from the condition during winter and spring. The predictors for the I refined forecast are: the number of critical ten-day periods with temperature above 10°C during the reactivation period. The stage of population dynamics of a new generation can be corrected using the values of hydrothermal ratio during the period from pest arrival to egg hatching and the number of months (from December to February) with temperatures of 3 or more degrees higher than normal. This approach permits an objective assessment of ecological situation on large areas and transition to development of all kinds of forecasts using personal computers. The algorithm presented can be used throughout the range of *Eurygaster integriceps*, e.g. in Bulgaria, Asia Minor and West Asia and Near East, etc.

#52

THE COMPARATIVE EFFECTIVENESS OF THE PHENOLOGICAL FORECASTING METHODS. E.D. Abashidze (Plant Protection Institute, 380062 Tbilisi, Republic of Georgia)

The treatment of the phenological forecasting of pests counts for much in the optimization protective measures. The comparative estimating of four forecasting methods-method of sum effective temperatures (SET), method of temperature-phenological nomogram (TPhN), forecasting method by air warmth content and regressive equations was carried. The model object was grape vine moth (*Lobesia botrana*) -one of the most dangerous pests in Georgia. It widely spread in vinegrowing regions of Georgia. In the result of comparative analysis of four forecasting methods, relatively high exactness of the TPhN-method was established. This method demands use of the system of equations. The SET-method uses one equation that is not correct. Forecasting method by air warmth content is recommended if precipitation and high humidity will be expected.

#53

THE AFFECTION OF ENVIRONMENT CONDITIONS ON THE INDUCTION AND TERMINATION OF DIAPAUSE OF FOXTAIL MILLET WEBWORM

Pan Xuexian, Cheng Kailu, Wang Yuanhong, Huang Fu, LIu Xinyi, Wang Zhiming (Rice and Sorghum Research Institute, Luchou, Sichuan 646100, China)

Foxtail Millet Webworm (Manpava bipunctella Ragonot) is a weak diapause pest of two generations per year in the south of Sichuan Province. Some larva in the first generation entered diapause no matter when it hatched. However, the quantative number increased with time and most of the larva in the second generation entered diapause. Photoperiod is the main stimuli inducing diapause. The response to the changes of photoperiod is between that of long day length diapause and that of short day length diapause pests. The number of pest entering diapause is decided by the photoperiod when they are in larva stage in middle temperature. The critical day length is 14 hours and 38 minutes at a constant temperature of 25 C and is longer as the temperature decreases, however, high temperature made no significant changes. The first and second instar of the larva are the sensitive stages to the photoperiod. The affection of temperature and food on the diapause largely depend on photoperiod. When the day length was less than 14 hours, all the larva entered diapause even through fed by different food and in different temperature conditions. Only when the day length is more than 14 hours, the food and temperature has profound modification on diapause. Low temperature can cancel the inhibition of long day length from diapause. Higher temperature, however, has no significant effect. More pests entered diapause when they were fed by corn than fed by sorghum and the number also increased with the development stages of the same kind of plants fed by pests. Long day length more than 14 hours are the essential factor to terminate diapause and the optimum temperature is 10 to 25 C. affections of diapause on the population dynamics and forecast were discussed.

#54

LIFE HISTORY OF *LAGRIA HIRTA* L. (COL., LAGRIIDAE) AND ITS ADAPTATION TO THE ENVIRONMENT. Hong-zhang Zhou (Institute of Zoology, Department of Physiological Ecology, University of Cologne, Weyertal 119, 5000 Köln 41, Germany)

Lagriidae are characteristic for tropical environments. In Central Europe the only common species is *Lagria hirta* L.. This species exhibits a univoltine life cycle with oviposition in July and August. The reproduction occurs only at temperatures between 15 and 25°C. The sexual maturation is mostly determined by temperature and slightly modified by photoperiod. The fecundity is greater in long-day (LD 16/8) than in short-day conditions (LD 8/16). If the beetles reproduce under LD 8/16, the mortality of eggs increases. The longevity of adults does not exceed 4 weeks when exposed to 15 - 25°C.

Pre-imaginal development proceeds from August throughout the winter months to June in the next year. However, none of the 10 larval stages is characterized by diapause. The larvae overwinter either in the 4th, 5th, or 6th instar. Usually one molt occurs during the winter. Pupation takes place in June. The thermal threshold for larval development varies from instar to instar. Obviously, this stage-specific temperature sensitivity adjusts the life cycle to the annual cycle.

The adults are polyphagous herbivores, which feed on the foliage of numerours shrubs and trees, but only specific host plants ensure successful reproduction (e.g. *Salix caprea* and *Sarothamnus scoparius*). In contrast to the adults, the saprophagous larvae feed on leaf litter and prefer leaves with low toughness and low contents of tannins.

#55

A COMPARATIVE STUDY ON SPERMATOPHORE SIZE IN BUSH-CRICKETS: EVIDENCE FOR NUPTIAL GIFT SIZE AS A SPERM PROTECTION DEVICE. Nina Wedell (Dept. of Zoology, Univ. of Stockholm, S-106 91 Stockholm, Sweden).

Males of many insect species provide the female, during courtship and copulation, with a nuptial gift of a prey item or synthesized material. These gifts may be explained as a form of paternal investment by increasing female reproductive output, or in terms of mating effort by increasing male fertilization success. These explanations, while not mutually exclusive, are controversial. This controversy may partly be the result of a failure to distinguish between the evolution and maintenance of this behaviour. While experimental studies can show the latter, comparative studies may be required to indicate evolutionary trends. Analysis of comparative data of 28 species of bush-crickets (Orthoptera: Tettigoniidae), reveals that male spermatophore size is positively correlated with female refractory period, which influences male fertilization success. Also, gift size was found to covary with ejaculate size, indicating that it functions to protect the ejaculate. In contrast, there is no significant correlation between any measures of female fecundity and male spermatophore size. This indicates that the variation in spermatophore size among tettigoniids has been influenced by a mating effort function rather than a paternal investment function.

#56

THE DISTRIBUTION OF CRANBERRY FRUITWORM, *ACROBASIS VACINII*, IN MASSACHUSETTS, USA, CRANBERRY BOGS. A. K. O. Rogers and A. L. Averill (Department of Entomology, University of Massachusetts, Amherst, MA, 01003, USA).

The oligophagous cranberry fruitworm, *Acrobasis vaccinii* (Lepidoptera: Pyralidae), is an important pest of cranberry, *Vaccinium macrocarpon* (Ericaceae), in most areas of North America where the crop is grown. The adult female oviposits singly into the calyx of host fruits; upon hatching, the emerging larva eats its way into the fruit and feeds internally, consuming from three to six fruits in close proximity as it matures.

A two-year investigation of the distribution of eggs in five commercial cranberry bogs in Massachusetts, USA, has revealed a high degree of contagion on several spatial scales. Certain berries and areas of bog receive many more ovipositions that would be predicted by chance. The distribution of larvae is also contagious, but less so than eggs. Both ecological and behavioral factors contribute to nonrandomness in oviposition; these include, but are not limited to, proximity to the margin of the bog, berry accessibility, and berry size. The distributions of eggs and larvae have been characterized mathematically, and the effects of sampling method and pest density thereon explored.

#57

THE RELATIONSHIP BETWEEN DENSITY AND PHASE TRANSFORMATION OF LOCUST NYMPHAL(LOCUSTA MIGRATORIA MANILENSIS MEYEN). Wen-chen Zhao, Jian-cheng Li(Plant protection Institute, Hebei Academy of Agriculture and Forestry Sciences. Baoding 071000, China), Shu-min Zhang, Jin-liang Liu etc., (General Station of Plant Protection of Hebei Province, Shijiazhuang 050021, China)

The relationship between density and phase transformation of locust nymphal was studied in 1988–1990. The results showed that the phase gregaria individual cann't appear under the density of 4 locust per m^2;In the density of 10–15 locust per m^2, the phase gregaria individual appear but isn't stable; If the density $\geq$ 20 locust per m^2, not only the phase gregaria individual appear, but the individual population grow with the increase of locust density. In the density $\geq$ 100 locust per m^2, the phase gregaria individual reach more than 90%. The field investigation show that when the maximum density of locust is 10 per m^2, and the average density $\leq$ 2per m^2, the phase gregaria individual don't appear; When the average density $\geq$ 10locust per m^2,the phase gregaria individual appear and their population grow with the increase of locust density. Therefore, When the maximum density of locust nymphal are 10 per m^2, the locust control is needed.

#58

STUDIES ON ENVIRONMENT OF THE WINTER HIBERNATING PUPAE OF ERI-SILKWORM(PHILOSAMIA CYNTHIA RICINI). Dong-jie Li, Ting-yin Liu(Institute of sericulture, Hebei Academy of Agriculture and Forestry Sciences, Chengde 067000,China)

We tested that after pupation the hibernating strain was preserved at the environment of 17℃ centigrade and R. H 90% for 30 days and then was stored at 3.5℃ centigrade. If the total overwintering pupae stage lasts more than 7 months, we can apply the method of restitution cold storage, that is, the eggs production were taken out of cold room in the middle of cold storage then preserved at 15℃ centigrade for 5 days, at last resumed cold storage at 3.5℃ centigrade in second year spring. The coccon for eggs production is moved away from the cold room to the environment at 10℃ centigrade in the same day, then the temperature is increased by 2℃ centigrade per day until the temperature has reached to 22℃ centigrade (R. H.80%) and maintained them until young moth is out. then the temperature is raised continuously to 24℃ centigrade (R. H 90%) and maintained here, then about 2 days later a great deal of moth will emerge. This treatment were best for fecundity.

#59

THE PREDATORY FUNCTION OF RANA NIGROMACULATA HALLOWELL ON THE OXYA CHINESIS (THUNB.) Yong-hua Zhang (The Provincial Station of Plant Protection of Anhui, Hefei 230031, China), Chao-zhang Tong (The Plant Protection Station of Fanchang County).

The predatory function of Rana nigromaculata Hallowell to the nymph of Oxya chinesis (Thunb.), which is one of the main pest rising in our country in recent years, was studied. Sets of models for different instars of the Oxya chinesis (Thunb) were developed to describe the relationship and their analyses were given in present paper among various prey density, predator density and cages. Regression functions for each instar in two cagetypes are as follows:

$y_1=-2.3541+0.3884x_1$ $r_1=0.9567$ $y_2=-1.1108+0.2357x_2$ $r_2=0.9742$

$y_3=-0.8108+0.1957x_3$ $r_3=0.9639$ $y_4=0.1081+0.1832x_4$ $r_4=0.9439$

$y_5=1.2811+0.1524x_5$ $r_5=0.9902$ $y_6=1.3487+0.1695x_6$ $r_6=0.8402$

$y_1'=1.4054+0.2321x_1'$ $r_1'=0.9814$ $y_2'=-0.1757+0.2197x_2'$ $r_2'=0.9573$

$y_3'=1.5297+0.1119x_3'$ $r_3'=0.7984$ $y_4'=-0.2514+0.3695x_4'$ $r_4'=0.9420$

$y_5'=1.2189+0.2776x_5'$ $r_5'=0.8152$ $y_5'=2.3595+0.3138x_5'$ $r_6'=0.8483$

Interference coefficient between predators in order for each instar was $m_1=1.7989 > m_4=1.7977 > m_3=1.7857 > m_5=1.7828 > m_2=1.7399 > m_6=1.5082$.

#60

STUDIES ON SELECTION OF EGG-LAYING OF OXYA CHINESIS (CHUNB) IN DIFFERENT STATES OF SOIL. Dao-hong Luo (The Plant Protection Station of Guangde County, Anhui Province 242200, China), Yong-hua Zhang (The Provincial Plant Protection Station of Anhui, Hefei 230031)

By using the method of outdoor investigation and raising in cage, egg-laying of Oxya chinensis (Thunb.) were studied in different soil hardness (harder, hard, soft), different soil type (clay-loam, sandy loam, sand silt), different water content of soil (watery, moister, moist, dry), different salineconcentration soil, different salt base saturation degree soil and soil mantle. The results show that Oxya chinensis liked better to lay eggs in sandy loam, numbers of egg were moister>moist>watery>dry; in different soil hardness, it would rather lay eggs in loose soft soil; in different saltbase saturation degree and saline concentration soil, numbers of egg decrease with saltbase saturation degree increasing; in soil poured NaCl, numbers of egg were very poor.It isn't signficant that Oxya chinensis laid eggs in different soil mantle. All above, the selection of egg-laying is apt large enviroument as site of egg-laying (host, soiltype, saline saturation degree), then micro-enviroument (soil, moisure, hardness) as site of egg-laying in same large enviroument; Aritificial simulation were similar to nature selection in results, but area of plot>20X 20cm^2, depth of soil>5cm.

#61

EFFECTS OF ECOLOGICAL FACTORS ON INCUBATION OF WHITE WAX SCALES. Chang-hai Zhang, Hua-qin Liu, Li-yuan Jiang (Resources Insect Institute of Chinese Academy of Forestry, Kunming 650216, China)

White wax production depends greatly upon inoculation and incubation of white wax scales. Incubation is affected by many ecological factors, among which are temperature, humidity, illumination, rainfall, cloud and wind. In normal condition, incubation occurs in the morning, seldom in the afternoon and never in the evening or at night. The starting temperature, humidity and illumination of incubation of white wax scales are seperately 12 ℃ , 80% and 100 lux; the optimum 18 ℃ - 25 ℃, 75%-45% ,and 12500-16000 lux; the ending 30 ℃, 22% and 2000 lux. Incubation of broodscales must be operated in the morning or at dusk in warm, windless, clear days, and must avoid cold, rainy and windy days, or otherwise a great loss may be caused.

#62

STUDY ON THE SPATIAL DISTRBUTION AND SAMPLING TACTICS OF THE PERSIMMON WOOLY SCALES. Shao Xu, Shun Liu, Man-yi Xiao (Department of Plant Protection, Hebei Agricultural University, Baoding 071001, China)

This paper deals with the spatial distibution and sampling tactics of the persimmon wooly scales, Eriococcus kaki Kuwana. It was found that the persimmon wooly scales were distributed mainly on the lower and middle layer of crown. Its distribution was aggregated in the all parts of crown, The aggregational intensities were different in different position on the crown of the tree and It was negative correlation with the persimmon wooly scale's population density. The value of the λ showed that the behavours of the persimmon wooly scales were responsible for its aggregation. The number of optimum sampling of the persimmon wooly scales was 681, When preciseness level was 0.2. In the same condition, the number of optimum sampling was 475, When the sampling parts was only in the east and west of the lower layer crown.

#63

Seasonal occurrence, effects of temperatures on development and distribution within tree of Mulberry scale, *Pseudaulacaspis pentagona* Tar.&Tozz.

Jong Dae Park[1], Kyu Chin Kim[2] , [1]Research bureau of Chonnam Provincial Rural Development Administration, Korea, [2]Dept. Agric. Biol., Coll. Agric., Chonnam Natl. Univ., Korea

Studies were conducted to investigate seasonal occurrence, effects of temperatures of each stage and distribution within tree of Mulberry scale, *Pseudaulacaspis pentagona*. Mulberry scale was most likely to have three generations a year with first occurrence of larval stage from mid.-May to late June, second occurrence from mid.-July to mid-August and third occurrence from early September to late October including 3 peaks in early and mid-June, late July and mid-September. Growth ratio of each stage with different temperatures was not significant within range of optimum temperatures of growth. Developmental threshold and effective temperatures of each stage were 12.3 and 46.9 DD in eggs, 10.8°C and 183.8 DD in first nymph, 9.8°C and 188.2 DD in second nymph, 10.3°C and 383.0 DD in gross nymphal stage, respectively. Longevity of female adults were 39.6 days in 18°C, 28.4 days in 22°C, 18.1 days in 26°C and 15.7 days in 30°C. Optimum temperatures of growth were 22-26°C. Distribution of each stege within tree in summer was great at lower part of branch and overwintering adults was dominantly located in NE-SE followed by SE-SW, SW-NW and NW-NE.

#64

THE OCCURRENCE AND MIGRATION OF RICE ARMYWORM, *Pseudaletia separata*, IN KOREA. Ki-Baik Uhm (Dept. of Entomology, Agricultural Science Institute, R. D. A., Suwon 441-707, Korea), and Joon-Ho Lee (Div. of Appl. Entoml., Dept. of Agricultural Biology, Seoul National Univ., Suwon 441-744, Korea).

Outbreaks of the rice armyworm, *Pseudaletia separata* Walker, have been observed every several years in pasture, rice, and other grain crops in Korea. This insect is suspected to be a migrant from overseas because it is not observed to overwinter, and is usually first collected by light traps in Dae-Heuksan-do, a south-western tip island, in Korea. To understand spatial-temporal dynamics of long-range migration of this insect, the moth populations have been monitored with light traps at 148 forecasting units throughout the country from 1987 through 1991. Immigration of the rice armyworm usually took place from mid-May through late June, which is about one month earlier than planthopper's immigration time. Also, the main invaded area by the rice armyworm were central parts of Korea(Kyung-gi and Kang-won provinces) which were not invaded much by immigrating planthoppers. The patterns of invasion, ① spatial occurrence, ② temporal occurrence, and ③ magnitude, are currently being analyzed. Also, various physical factors such as weather and biological factors which are important in regulating the rice armyworm migration are currently being studied.

#65

THE LIFE HISTORY OF TWO FLEABEETLE SPECIES OF THE GENUS ARGOPISTES (COLEOPTERA : CHRYSOMELIDAE), WITH SPECIAL REFERENCE TO THE ADULT DIAPAUSE. Takenari Inoue (Forestry and Forest Products Research Institute, Asakura, Kochi 780, JAPAN)

Two closely relate fleabeetles, Argopistes coccinelliformis (Ac) and A. biplagiatus (Ab) are univoltines, with hibernation occuring during adult stages in central Japan. Overwintered adults lay eggs on new sprout in spring and new adults emerge in early summer. Ac prefer evergreen Oleaceae and Ab prefer deciduous Oleaceae.

At 20℃, Ac females collected from early summer to autumn needed a long preoviposition period under a long (15L-9D) photoperiod but they never laid eggs under a short (12L-12D) photoperiod. Females collected in late autumn or early winter requierd only a short preoviposition period under both photoperiods, but the preoviposition period was prolonged and the numbers of eggs laid was restricted under the short photoperiod. On the other hand, some newly-emerged adults could oviposit when supplied with new leaves soon after eclosion. Thus, Ac may be a 'partial multivoltine' insect in central Japan. In contrast with this, newly emerged females of Ab collected from early summer to autumn never laid eggs under the long nor short photoperiods. Females collected from late autumn to mid-winter laid eggs under the long photoperiod but under the short photoperiod. In early spring, they could lay eggs under both photoperiods. Therefore, Ab undergoes two kinds of diapause — aestival and autumnal-hibernal diapause in a single adult stage, and it is correctly univoltine.

#66

Attraction of the Male Brown-winged Green Bug, Plautia stali SCOTT to the Same Species and its Phasiid Parasitoid, Gymnosoma rotundatum LINNE. Hiroshi FUKUDA[1], Seiichi MORIYA[2], Hajime SUGIE[3], Kenjiro KAWASAKI[3], Azusa FUJIIE[1] and Masakazu SHIGA[3]

[1]Chiba Prefectural Agricultural Experiment Station, 808 Daizenno-cho, Chiba-shi 280-02, Japan. [2]Fruit Tree Research Station, 2-1 Fujimoto, Tsukuba-shi 305, Japan. [3]National Institute of Agro-Environmental Sciences, 3-1-1 Kannondai, Tsukuba-shi 305, Japan.

Attraction of adult males of P. stali to the same species and its parasitoid was investigated. The number of bugs attracted to caged adult males(male trap) increased in early summer and in autumn, while the number of bugs caught by a light trap reached a peak in midsummer. Dissection of trapped individuals showed that the physiological conditions were considerably different between the individuals attracted by males and those caught by the light trap. Adult males began to attract others 7-10 days after the emergence. Male bugs attracted to the male trap showed no attractiveness by themselves unless they received a sufficient amount of food. There was a close relationship between the phenomenon of attraction and the food conditions of the bugs. Since adult males also attracted a parasitoid, G. rotundatum, the aggregation pheromone acted at the same time as a kairomone for this parasitoid. Separation and identification of the substance(s) involved are currently being undertaken.

#67

COMPARATIVE STUDIES ON THE DISTRIBUTION AND LIFE HISTORY OF THE TWO GIANT WATER BUGS, DIPLONYCHUS JAPONICUS AND D.major. Hiroaki Okada (Department of Upland farming,Tohoku National Agricultural Experiment Station, Arai, Fukushima, Japan)

Two species of giant water bugs, Diplonychus japonicus and D.major (Belostomatidae) have different distribution patterns in western Japan. D.j tends to occur in low lands while D.m in hilly regions. To clarify the differences in the habitat selection and life history between species, we investigated the distribution pattern, seasonal occurrence and food menu of the two giant water bugs in Okayama, western Japan. We also compared the developmental zero of nymph between species in laboratory. The results were summarized as follows:

Species	D.japonicus	D.major
Habitat type	Seasonal pool, farm pond, paddy field,etc	Farm pond, paddy field,etc
Water temperature of habitat	High	Low
Reproductive period	April-September	May-August
Voltinism	Partial bivoltine	Univoltine
Development of nymph	Fast	Slow
Main food	Snails	Dragonfly nymphs, conspecific nymphs
Developmental zero	High	Low

#68

FLIGHT MUSCLE DIMORPHISM OF THE FEMALE ADULTS AND ITS GEOGRAPHIC VARIATION IN THE YELLOWISH ELONGATE-CHAFER. Heptophylla picea Motschulsky (COLEOPTERA: SCARABAEIDAE). S. Tada[1]. K. Honma[2]. J. Nishigaki[3]. K. Fujisaki[1] and F. Nakasuji[1] ([1]Laboratory of Applied Entomology. Faculty of Agriculture. Okayama University. Tsushima-naka. Okayama 700. Japan: [2]National Research Institute of Vegetable. Ornamental Plants and Tea. Kanaya. Shizuoka 428. Japan: [3]Laboratory of Applied Entomology. Faculty of Agriculture. Shizuoka University. Ohya. Shizuoka 422. Japan.)

In the yellowish elongate chafer. Heptophylla picea. all male adults had well-developed flight muscles. whereas female adults presented a flight muscle dimorphism. Female non-flyers did not retain any flight muscles even just after eclosion. These adults reserved fat-body in their thoracic cavities. Female adults without flight muscles developed their ovaries with the degeneration of fat-body during their stay in the soil. There was a geographic variation in the incidence of the female adults without flight muscles. The proportion of female adults without flight muscles varied from 0 to 100 % in Japan.

#69

OVERWINTERING EGG DIAPAUSE IN THE APHID, DIFFERENCE IN TWO TYPES OF APHIS SPIRAECOLA PATCH.

Shinkichi KOMAZAKI (Kuchinotsu Branch, Fruit Tree Research Station, Kuchinotsu, Nagasaki, 859-25 Japan)

Aphis spiraecola overwinters holocyclically on spirea and citrus plants. Hatch timing differs more than a month between eggs on these hosts. Egg diapause in the overwintering egg was studied under various thermal conditions. The method of collecting eggs on the filter paper and the timing of egg sterilization were also studied. Eggs on the wetted filter paper were kept at 14°C for 7days. After this period, the color of fertilized eggs turned black. These eggs were chilled at the low temperature (4.2°C or 6.3°C) for various periods and transferred to the temperatures at 10, 12, 14 or 16°C. Longer low temperature incubation resulted shorter egg period after chilling. The higher temperature incubation shorten the egg period after chilling. Eggs hatched without chilling from 10°C to 14°C. Total duration of egg stage did not differ so much among various periods of chilling but was greatly affected by the temperature after chilling. Under the same thermal conditions, egg stage lasted longer in citrus overwintering type than in spirea overwintering one. The great difference existed in two types of overwintering egg diapause.

#70

FECUNDITY AND MULTIPLE MATINGS OF THE CABBAGE BUTTERFLY, PIERIS CANIDIA INDICA, IN CHIENG MAI, THAILAND. Ando, S. & M. Watanabe (Department of Biology, Faculty of Education, Mie University, Mie 514, Japan)

Mating frequency in wild females of Pieris canidia indica was examined with dissection of bursa copulatrix. Young females usually had a spermatophore, suggesting that they had mated soon after eclosion. The aged females had mated triple on average. A virgin female loaded about 300 immature eggs, and about 200 eggs seemed to be actually deposited throughout their life span irrespective of their mating frequency. No relation was found between the volume of a mature egg in ovaries and the mating frequency. The volume of each spermatiphore inseminated was important for reproductive success in females of the species.

#71

MATING FREQUENCY AND FECUNDITY OF THE ANDROMORPH IN COLIAS ERATE (LEPIDOPTERA: PIERIDAE). M. Watanabe, S. Ando (Department of Biology, Faculty of Education, Mie University, Tsu, Mie 514, Japan)

Females of the butterfly, Colias erate, exhibit a genetic color dimorphism in which one form has white wings (heteromorph), and the other resembles the males with yellow wings (andromorph). In summer generation, 14% (1989) and 12% (1990) of females captured were andromorphs. Throughout their life span, they copulated half as often as did heteromorphs. The bursa copulatrix enlarged with the number of spermatophores contained. Fecundity of each morph after eclosion was about 800. There was no significant difference in the number of eggs loaded by andromorphs and heteromorphs, when they had copulated once. The number of eggs actually laid by heteromorph depended upon the mating frequency. The heteromorphs may use male-derived stimulants to increase their reproductive output. However, in the old stages, either andromorph or heteromorph had actually laid about 500 eggs. The polymorphism is probably balanced by the number of eggs developed by the andromorphs, though their low mating frequency.

#72

THE SURVIVAL DEVELOPMENT AND OVIPOSITION ON THE HEMP PALM SCALE, (ABGRALLASPIS CYANOPHYLLI (SIGNORET) (HOMOPTERA: DIASPIDIDAE), AT CONSTANT TEMPERATURES. Weimin Bao, Gaoxian Zhang & Guofeng He (Research Institute of Entomology, Zhongshan University, Guangzhou 510275, China)

Effects of temperatures on survival, development and oviposition of the hemp palm scale, Abgrallaspis cyanophylli (Signoret), were studied at six constant temperatures. The number of the crawlers survived declined with increasing temperature, but no significant differences were found for the number of the survived scales settling on potatoes at each temperature. For one generation,the highest percentage of the scales survived was at 25°C (with 75.9%) and the lowest at 30.0°C (with 44.7%). The development zero and the effective accumulative temperature for each life stage of A. cycnophylli as well as egg- to- adult were estimated. The upper development limit of temperature for A. cyanophylli could range from 30.5°C to 31°C . The duration of the female oviposition decreased with increasing temperatures, from 63.3 days at 20.0°C to 35.8 days at 28°C, and the number of eggs laid per female increased with temperature. The oviposition of female was inhibited at 30.0°C. Eleven experimental population life tables of A. cyanophylli were constructed, and the essential parameters for investigation were calculated.

#73

THE INFLUENCE OF TEMPERATURE ALTERNATIONS WITHIN MODERATE-HIGH TEMPERATURE RANGE ON RATE OF DEVELOPMENT IN TWO INSECTS. Wu Xiao-jing, Liu She-sheng, Zheng Zhong-liang(Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

This paper reports a study of the influence of temperature alternations on rate of development in Trichogramma dendrolimi and Diaphania indica. Temperature ranges are designated according to the species' relationships between temperature and rate of development as well as mortality under constant conditions. "Moderate temperature range" includes the range within which development rate increases proportionally and mortality remains low with increase in temperature, while "high temperature range" includes the range within which development rate decreases and mortality increases rapidly with increase in temperature. In Trichogramma dendrolimi temperature alternations did not affect the rate of development within the moderate temperature range, but showed some accelerative effect when temperatures alternated between moderate and high ranges. In Diaphania indica, temperature alternations did not show any accelerative or decelerative effect on rate of development within moderate-high temperature ranges.

#74

MALE REPRODUCTIVE COSTS IN MEGALOPTERA.

Fumio Hayashi
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Male Protohermes (Corydalidae: Megaloptera) attach a spermatophore externally to the female genitalia at copulation. Following separation the female bends and eats this large gelatinous spermatophore. Males have a large internal reproductive organ consisting of testes, accessory glands and spermatophore sacs in which the spermatophore is prepared before mating. The reproductive organ of P. immaculatus was smaller and recovered more rapidly after copulation than that of P. grandis. Male P. immaculatus were able to remate daily, while P. grandis required about two days until remating. Thus, P. grandis that invest more heavily in each spermatophore (7.2-20% of body weight) require longer periods between matings than P. immaculatus producing relatively small spermatophores (2.3-10% of body weight).

#75

FOOD PREFERENCE OF FOUR STORED PRODUCT PESTS IN LEPIDOPTERA. Jingyuan Xuan (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

This paper reported the preference of four stored product pests in Lepidoptera in 1990-1991 in Chongqing. Eight kinds of stored grain and food used for the preference by Indian meal moth, almond moth, meal moth and black rice worm in room condition. The results showed that on the four kinds of grain, the all of four species adult females preferred to lay eggs on rice, grain, followed sorghum, and they did not show much interest in wheat and maize. When eigth kinds of lara's diedt were offered. The Indian meat moth always inclined to lay their eggs in large amonuts on dried grape, they showed ten ency to the substance containing sugar and acid.

The newly hatched insect of Indian meal moth showed feeding on the eggs deposited foods, and then some larvae began to remove among the dried fruits after eggs hatched 5 days. Its number varied in each foods. The larvae on the drieal grape with a good many eggs showed preference to kervel walnut, however they did not show the preference in peanut grain, chilli and wheat. The numbers usually fluctuate, a decline being generally associated with the pest increase in density, or with the nutrition and hardness and dryness of food, using it as a source of food.

When larvae of Indian meal moth and meal moth feeding the stored grain, the mortality, was higher, about 14.599%-33.93 and 0% of them survived respectively after eggs hatched 9 dadys. It may be due to the effect.of grain's hardness and dryness.

#76

STUDIES ON THE BIONOMICS OF HIEROGLPHUS ANNULICORNIS (SHIR.) (ORTHOPTERA: ACRIDIDAE). Guan-dou Huang, Xiang Zhou (Depertment of Plant Protection, South China College of Tropical Crops. Danxian Hainan, 571737,China)

Hieroglyphus annulicornis (Shir.) is one of the more important pest in sugarcane (Saccharum sp.) cultivated in Hainan. It breeds one generation annually in Hainan Island. The egg period covers 233-244 day; the larval stage takes 70-75 days; the adult only lasts 70-80 days. The adults appear from end-April to mid-May.

By spraying Cyfluthruin in the field, the pests could be effectively controlled.

#77

INITIAL STUDIES ON OCCURRENCE PRINCIPLES AND CAUSES OF OUTBREAKS OF LOCUSTA MIGRATORIA MANILENSIS (MEYEN) IN LOCUSTA AREA IN SOUTH-WESTERN HAINAN. Guang-dou Huang, Shi-yong Wang, Zong-dao Huang (South China College of Tropical Crops, Danxian Hainan, 571737 China), Hong-chang Li, Qing-cheng Long(Institute of zoology, Academia Sinica, Beijing 100080, China)

This paper is about the occurrence principles and characteristics of Locusta migratoria manilensis (Meyen) from 1987 to 1989. It analysed the main causes of the formation of the locusta area and outbreabs in the south-western Hainan. It provided the scientific basis for integrated control of L. migratoria manilensis (Meyen) on Hainan Island.

#78

EFFECTS OF SALINITY ON DEVELOPMENT OF AEDES TOGOI.Hong,Han-Kee Kim,Chi-Moon, Yang,Young-Cheol(Dept. of Biology,Incheon Univ.In-cheon Korea)

Studies on the effects of different salinity of the breeding water on the development and the contents of lipids and protein of Aedes togoi were carried out in insectory, the results obtained are as follows: 1. Observing egg laying preference to the eight different water salinity,36.1%,38.2% and 23.0% of the eggs were laid on 0%,1% and 2% salinity respectively, and few eggs(less than 3%) were found on the higher salinity(>4%). 2. The developmental period of the larval stage was in average 9.4 days and 9.3 days under the condition of 1% and 2% water salinity respectively, that was the most favorable growing condition compared to the other salinities. 3. The body weight and size of the adults which were developed in the 1%-2% salinities showed significantly larger than the other groups. 4.Comparing the egg development of A. togoi reared at eight different salinities, the females reared at 2% salinity were showed not only every Christopher's stages but also autogeny, while the others were showed only upto Christopher's II stages. 5. The lipid and protein contents of the females developed in 2% salinity of the water were the highest among all test groups, showing 0.251mg and 0.754mg respectively. 6. Comparing the patterns of protein A. togoi, the total protein was showed as similar aspect, however the larger size of main bands were observed from the mosquito reared at the higher salinity than the low salinity, and the band of adult was appeared in 43-60Kd, while the pupa in 60-67Kd.

#79

SWARMING OF THE BROWN LOCUST, *LOCUSTANA PARDALINA*, IN RELATION TO RAINFALL IN SOUTHERN AFRICA. S.A. Hanrahan, J. Lindesay, P. Nailand (Department of Zoology, University of the Witwatersrand, WITS 2050, South Africa)

Recent analyses using Leslie matrices and logistic equations for population growth showed that endogenous factors alone could not account for irruptions of the brown locust in the semi-arid western regions of southern Africa. Earlier studies had suggested a link between rainfall and increase in locust numbers. Our first analysis of rainfall data and number of magisterial districts infested with locusts over a period of 75 years suggested that lack of rainfall from June to September, followed by rain were conducive to locust increase, while wet winters and early summer were correlated with years of locust decrease. These relationships have now been examined for the whole outbreak area in much greater detail. A simulation model using available data on brown locust life cycle and population numbers was constructed was used to test these findings using hypothetical climate data. Inspection of weather data and reports of locust swarming at specific stations at 3 periods of swarming and recession were carried out to test these ideas. The unexpected correlation between swarm development and dry periods followed by rainfall rather than a direct correlation of swarm development to high rainfall which puzzled earlier workers is probably related to the conditions for breaking of egg diapause.

#80

DOES *OTHIUS PUNCTULATUS* (GOEZE) (COL., STAPHYLINIDAE) MAINTAIN AN OBLIGATORY MONOVOLTINE LIFE CYCLE IN THE DIFFERENT HABITATS OF THE PALAEARCTIC REGION? Zhou, H.Z.; W. Topp (Zool. Inst. Univ. Köln, Physiologische Ökologie, D-5000 Köln 41)

Othius punctulatus is a predaceous rove beetle which inhabits the litter layer of forests. It has a wide geographic distribution and occurs in almost the whole palaearctic region. The populations studied, which originated from West- and Central Europe, showed obligatory univoltine life cycles. Thermal and photoperiodic sensitivities of adults determine the phases of reproduction and adjust the individual life cycle to the annual cycle. The stage-specific thermal thresholds and the photoperiodic response of the 3rd instar contribute in synchronizing the development within a population. The specific reaction patterns of the individuals studied are also the prerequisites for a successful obligatory monovoltine life cycle in most parts of the palaearctic. Four different phenological types are predicted: 1. a Mediterranean type with reproduction from December to March, 2. an Atlantic type with reproduction from September to May, 3. a Continental type with reproduction from September to May interrupted by a state of quiescence, 4. a Siberian type with reproduction in May and June.

#81

THE EFFECT OF SO_2 POLLUTION ON THE DEVELOPMENT OF GREEN PEACH APHID. Kun-jun Wu, Pei-yu Gong, Xiu-zhen Li(Institute of Zoology, Academia Sinica, Beijing 100080,China), Jian-min Shu, Hong-fa Cao(Institute of Ecology, Chinese Academy of Environmental Sciences, Beijing 100000,China)

The effect of SO_2 pollution on the growth and reproduction of green peach aphid Myzus persicae(Sulzer) was studied by rearing this insect on rape leaves exposed to 40-160 ppb of SO_2 concentrations. Under low concentration of SO_2, especially the 80 ppb treatment, the growth of this aphid was significantly accelerated, the mean relative growth rate, fecundity and intrinsic rate of increase(r_m) were 31.5, 89.6 and 38.4% higher than the control, respectively. The high SO_2 concentration obviously suppressed.the growth and reproduction of green peach aphid. The results of biochemical component analyses showed that the effect of SO_2 pollution on M. persicae is possibly related to the change of total amount of free amino acids in rape leaves, and it is more reasonable to express by the change of methionine content.

#82

MICRO- AND MACROELEMENT ACCUMULATION BY CERAMBYCIDS AT DIFFRENT STAGES OF PINE WOOD DECOMPOSITION. Alexsey V. Yesenin(Institute of Evolutionary Morfology and Ecology of Animals,Leninsky prospekt 33, 117071 Moscow, Russia)

Mean K,Ca,Mg concentration in larvae Arhopalus rusticus and Anastrangalia reyi were similar, but mi microelements concentration in them were significantly different. Al concentration in A.rusticus was 11, in A.reyi was 100 ppm dwt. It is result of A.reyi feeding at last stages of wood decomposition, when Al is more available under organic acid impact.

Ratio Mg/Ca in A.rusticus gut was from 3 to 4 and in A.reyi from 1,6 to 1,8. Ratio K/Ca in A.rusticus gut was from 89 to 90 and in A.reyi gut between 53-54. These differences can be of result of result of gut microflora activity in different species.

#83

CAUSES OF MIGRATIONS OF LEPIDOPTERA IN THE PALEARCTIC L.P. BERGER (Institute for Plant Protection, Pushkin, St.-Petersburgh--Leningrad, 189620, USSR).

It has been shown that the ranges of some migratory Lepidoptera become extended to the north due to meteorologically driven long-range dispersal of insects during the years of active atmospheric circulation and intensive movement of air masses from the south.

In 1987 there was a heavy flight of Plutella maculipenis Curt in the Europpean part of the USSR and in Baltic countries observed against the background of active cyclogenesis over the south- western part of the Europpean Continent. The cyclones that originated here moved over Italy, Greece and Turkey driving air masses to the north . The process took about 20 or 25 days. One part of the cyclones passed into the northern lalitudes and dissipated over the north- western region of the USSR. The moths appeared here in early June, being so numerous that daily captures were about 100 males per pheromone trap. During the subseguent years when the atmospheric processes calmed down the population decreased.

Migrants of Mythimna separata walh were observed in Priamurye and Primorski Kral of Russia when the zone of cyclogenesis was over the southeast Asia in late spring. The originating cyclones, and especially those that had the pressure in the centre of less than 990 millibar , created a favourable situation for migration of this pest from the south of its range to the north.

STUDIES ON THE PHOTOTAXIS OF PEACH FRUIT MOTH. Wu-wei Hou, Wei-zeng Gao, You-fen Ma, Shi-wen Li (Institute of Zoology, Academia Sinica, Beijing 100080,China)

The peach fruit moth Carposina nipponensis Walsingham was generally believed to be active at night without reaction to phototaxis. In order to make clear whether it is phototactic, five kinds of monochromatic lights with wavelengths at 350,375, 405,383 and 333 nm respectively were used to test the phototactic response of this moth in a behavior test apparatus. The results showed that the 350 nm was most effective for its phototactic response, the differences among the mean phototaxis values of different wavelengths were compared. In field test, four 20 w light traps with different wavelength compositions, namely, double black-green (355 and 530 nm), black blue (355 and 435 - 460 nm), black-orange (355 and 560-600 nm) and usual black light, were placed 50 m. apart from each other in a jujube orchard. The data of trapped moth number in two years indicated that the black green light was most effective in peach fruit moth trapping

STUDY OF MECHANISM OF EFFECT OF SECONDARY SUBSTANCES IN SEED STONE OF *MELIA AZEDARACH L.* ON GROWTH AND DEVELOPMENT OF COTTON BOLL WORM. Yun-tai Qi, Guo-ming Chen, Song-yun Wu (Shanghai Institute of Entomlogy, Academia Sinica, Shanghai,200025,China)

There is a close co-evolutionary relation between plants and insects. The plants possess defensive ability to pest damage; The insects possess adaptable ability to the plants. Secondary substances in seed stone of *Melia azedarach L.* showed a serious effect on growth and development of cotton boll worm and caused larva death. The effect was not reversible. Change of enzyme system in larva bodies of cotton boll worm which fed extract of *Melia azedarach L.* seed stone was determined by enzymological method and polyacrylamide gel electrophoresis technique. An apparent change of specific activity of carboxylesterase and phosphoesterase was discovered. Their specific activity showed a graduual increasable tendency generation by generation. There was no change of specific activity for acetylcholinesterase and glutathiontransferase. The results indicated that the carboxylesterase and phosphoesterase play important role for overcoming food selective pressure. The study has great significance for screening effective plant insecticides, culturing resistance plant strains to pests and elucidating theory on insect underspecies divition and new species generation.

ON THE SCREENING TECHNIQUE FOR RESISTANT MILLET VARIETIES TO MILLET STEM MAGGOT AND THE RESISTANCE MECHANISM. Zhong-min Zhang, Qi-hua Yang (Department of Plant Protection, Beijing Agricultural University, Beijing 100094,China)

An improved technique for screening resistant millet varieties to millet stem maggot Atherigona biseta Kall, with optimum inoculation stage, density and position on millet plant and a series of technical indices were proposed. The effect of related chemical contents, morphological characters and developmental stages of test varieties on the resistance of millet were analyzed. The results showed that the tannin is an important chemical, and the pubescence density on leaf surface and thickness of stem, etc. are the important morphological characters to A. biseta resistance. The changes of chemical contents of millet plant before and after the invasion of stem maggot were compared. Finally, the induced insect resistance of millet was explored.

EFFECT OF COTTON PLANT AGES TO THE INTRINSIC RATE OF THE COTTON APHID POPULATION INCREASE----A Study on Why Cotton Aphid Population Growth Is Rapidly inJuly's Dog Days. Qi-ming Pan, Tian-she Wu, Lin-shui Zhang(Cotton Research Institute,Shanxi Agri. Sci. Academy, Yuncheng 044000,China)

During 1981--1983, we did experiments on the intrinsic rate of the cottonaphid population growth. Under same weather conditions each year, equal initial amount of no-wing-aphids were introduced to cotton plants of different ages in isolation from wing-aphids and natural enemies. The results show thatafter 20 days the population growth rate of the aphids introduced to the plants as old as that in the field in early July (12 stem-leaves old) increasedby far greater than that introduced to the plants as young as that in the field in early May (cotyledon plants), the former increased as more as 646--3244 times, but the later only 33--454 times. That can be preliminarily attributed to the higher plant and larger leaf area, and the higher content of protein N. Therefore, our tentative conclusion is that the improvements of both nutritional and habitat conditions compensated the adverse weather conditionsin July, caused the rapid population growth of cotton aphid even in temperatures much higher than its optimum growth temprature (24 C), and resulted inthe dog-days-aphids.

A STUDY ON RELATIONSHIP BETWEEN YIELD LOSSES OF MAIZE AND THE DAMAGE OF ASIAN CORN BORER (OSTRINIA FURNACALIS). Feng-ming Yan (Department of Biology, Peking University, Beijing 100871, China)

In July, 1991, the study on relationship between yield losses of maize "Danyu 13" and the damage of Asian corn borer (Ostrinia furnacalis) was taken in Baoding, Hebei Province. When harvesting, plants with 0, 1, 2, ..., 9 damage holes were chosen respectively to record and calculate the average yield and the 1000-seed-weight of the single plant. In comparison with the yield of plants with 0 damage holes, we made two equations: 1) about relationship between average yield losses of single plant and the number of damage holes, $\hat{y} = 42.4236 + 9.3262\ \hat{x}$, $r = 0.9038$, here the coefficient is very significant; 2) about relationship between average 1000-seed-weight losses and the number of damage holes, $\hat{y} = 63.3741 + 0.7885\ \hat{x}$, $r = 0.1333$, here the coefficient is not significant. The resusts show that we must evaluate the yield losses in accordance with the average single plant yield relevent to the number of damage holes rather than the average 1000-seed-weight to the number of damage holes.

STUDIES ON THE POPULATION DYNAMICS OF ANOPLOPHORA GLABRIPENNIS MOTHSCH Xian-qian Liu, Zhi-yong Zhang (Forestry Department, Shanxi Agricultural University, Taigu Shanxi 030801, China), Shou-ren Wang (Control Station of Houma Bureau of Forestry), Huai-jian Zhao(Control Station of Linfeng District Bureau of Forestry), Zhen-wang Miao(Station for forest disease and pest control and quarantina of Shanxi)

In order to reveal the population dynamics of Anoplohora globripennis Motsch, the natural population of the pests was investigated by using the method of "thack investigation" at Houma, Yuncheng areas in 1987-1988. The results are as follows.

1. The average densities of the population were obtained in various forests in which the pests have invaded in different years.

2. The spatial distribution patterns for eggs, larvae, pupae and adults of the pests all were obeyed to aggregation distribution. The lower population densities were, the higher degree of aggregation were.

3. The life tables of natural population of the pest were made in various forests.

4. The key factors influencing the population dynamics were the predation by several natural enemies during the first stage of larvae.

5. Based on the above points, the equations were developed to predict the amount of the pests.

THE COMPONENT ANALYSIS ON INFEST IN ECOLOGICAL SYSTEM OF FARMLAND. Qing-sen Li, Ji Li (Institute of Plant Protection, Shanxi Academy of Agriculture Sciences, Taiyuan 030031, China)

Authors had systematically analyzed the component of infest on agro-ecosystem in Shanxi province starting out biocenosis component, nutrition structure and niche breadth. The results showed that there are 4128 species of infest. Biocenosis are mainly composed of phytophagous insects, secondarily diseases and weeds. Their nutrition structure which vary with different crops showed spacestratifying and time-simultaneity. Those diseases, pests and weeds which are important in the production often have wide breadth, niche overlap are also different.

POPULATION DYNAMICS OF THE BROOWN PLANTHOPPER, NILAPARVATALUGENS (STAL), IN SHANGHAI REGION AND ITS CONTROL OPTIMIZATION DECISIONS. Jian-yi Huang, Ro-duo Li (Plant Protection Station, Chuansha County, Shanghai 201201, China), Li-zheng Qi (Nanjing Agricultural University, Nanjing 210014, China)

From 2,614 field surveys and dissection of 15,417 females, population dynamics of brown planthopper on singlecropping late rice, its economic damage, and control decisions were studied in Shanghai region. Immigration was from the South and 3to4 generations occurred. Population dynamics was related to life parameters of planthopper and these in turn were limited by factors such as climate, cultural measures, etc. Economic loss due to insect damage were related to its population density, and developmental stages of rice plant, etc. Polulation sdudies showed: for population management the boxcar train principle could be used in constructing a simulated model of planthopper population dynamics, and a model of control optimization decisions was constructed based on Bellman method of dynamic programming. Data on population dynamics from simulated model and field were well matched through years 1984 to 1989 in forecasting plots. In planthopper population control application of model decisions worked better than routine decisions and gained maximum economic profit.

RELATIONSHIP BETWEEN THE INJURE AND YIELD LOSS OF THE MILLET LEAF BEETLE PACHNEPHORUS LEWISI BALY. Cheng Hong-zuo, Li Xue-qing, Zhang Jing-she (Millet Research Institute, Shanxi Academy of Agricultural Sciences, Changzhi 046011, China), (Vegetable Research Institute, Shanxi Scademy of Agricultural Sciences, Taiyuan 030031).

The millet leaf beetle feeds on leaves causing mortality. The regression formula of larvar density with the fresh weight of leaf is $\hat{y}=11.423-0.012x$. The degree of damaged leaf is analyzed by the formula. If feed on 50% leaves of one third plantlets, the yield loss only is 1.19%. If feed on 50%leave of one decond those, the yield loss only is 8.16%. While feed on 50% leaves of all plantlets or top removal, the yield of millet decrease dramitically. The economic injure level is 4.17%. The economic threshold is 1.93 individual larvae in a plantlet.

OBSERVATION OF THE MOVEMENT ABOUT THE LOCUSTA MIGRATORIA MANILENSIS, Chun-guang Ren (An Xin Plant Protection Station. An Xin 071000, China)

The Locusta migratoia manilensis (Mey.) is a serious insect pest in my country. The present paper deals with a prcliminary study on the observation of the movement about the Locusta migratoria manilcnsis. The writer rescarched the change of colony's numbers of the Locust migratoria manilensis in different time, temperature, brightness, place and position in 1990. The result is that the difference in area A(time). B(place). C(position) and mutual act area A × B. A × C. B × C and A × B × C are all notable.

The action that different element give the coloney's numbers, big or small, the order is B × C > B > A × B > C > A > A × C > A × B × C.

EFFECTS OF TEMPERATURE AND RELATIVE HUMIDITIES ON THE GROWTH AND DEVELOPMENT OF THE RICE LEAFROLLER, CNAPHALOCROCIS MEDINALIS. Gui-fen Zhang, Qin-xuan Liu (Institute of Plant Protection, Henan Academy of Agricultural Sciences, Zhengzhou 450002, China)

Effects of TEMP and R.H. on the growth and development of the egg, first instar and pupa of rice leafroller have been studied at the laboratory. The R.H. were set at 40, 60, 80, 100% and controled by Solomon (1951) and Winston et al. (1960) methods at a closed glass container of one liter volume in 25°c and 32°c constant TEMP conditions, respectively. The results indicated thet TEMP is a main affecting factor for the developmental rate from the egg to pupa of the rice leafroller, while the R.H. has an effect on the survival of all the stages. When the R.H./TEMP was above 2.4, the hatching of the egg is not apparently affected. As the coefficient was reducing, the egg is too serious loss of water to complete embryonic development and the mortality rate of the egg increases. The combination between 25-32°c and 80%RH was the most advantageous for the survival of newly larvae, pupation and emergence. The pupa and moth of deformity often occured below 60%RH. This showed that it may be possible to minimize damage to rice in the year if there is a high TEMP and dry atmosphere during occurence of the rice leafroller.

A PRELIMINARY STUDY ON THE INTRASPECIFIC VARIATION OF THE TOBACCO APHID MYZUS PERSICAE(SULZER)(HOMOPTERA, APHIDIDAE)AND THE MECHANISM OF ITS POPULATION DYNAMICS. Gaoping Wang, Zhongl in He(Henan Agricultural University, Zhengzhou 450002, China)

Ecological observation and physiological analysis of the tobacco aphid Myzus persicae with different body color were made in Henan. We considered, (1) the red form of tobacco aphid is the intermediate physiological strain between the purplish-brown and green forms. The purplish-brown form may change into the red form; the red and green forms may transfer mutually to each other, (2) the red form is the ecotype to survive the high temperatures(25-31℃) during the rapid growing stage of the flue-cured tobacco, while the green form is the ecotype adapted to lower temperature (20℃). The graph of population dynamics of apterous tobacco aphid in spring tobacco field looks like the saddle of a horse (∩) and this is a regular pattern in Henan. The aphid peak stage occurred in early and middle May is related to the alate tobacco aphid which flies continuously into the spring tobacco field. The low population of apterous aphid in late May and early June is mainly caused by the rise of temperature and the sharp decline of the relative humidity(the average temperature of 5 days is above 26℃ and R.H. is below 64%), while the function of the Aphidiidae wasps and the lady beetles is quite limited.

OPTIMAL BREEDS ARRANGEMENT FOR CONTROLLING PESTS. Wen-jun Zhang, Shi-ze Wang (Northwestern Agricultural University, Yangling, Shaanxi 712100, China), Yan-hong Qi (Northwestern Institute of Soil and Water conservation of Academic Sinica, Yangling, Shaanxi 712100, China)

Rational arrangement of breeds takes the predominant position in the integrated pest management. Up to now, there haven't any detailed study to optimization of breeds arrangement in China or abroad. So, this can't meet the urgent needs of pest management.

This study first provides a optimal algorithm for breeds arrangements aim to control the pests. In this study, the optimal arrangement of cotton breeds for controlling cotton aphid was determined using Optimal Mixed Tactics of Ranking Probability (OMTRP). According to net income under different damaging of cotton aphid and the future prediction, we got the optimal arrangement of 3 cotton as follows: 52.3%, 45.6%, 1.98%. This result was maintained by sensitivity analysis. Meanwhile, all of the optimal tactics were given for different situations.

Finally, the computer software is given for OMTRP. This software is very useful in building expert system of integrated pest management. Also, the optimal tactics under many pests or weather conditions can be determined by OMTRP.

A STUDY ON THE POPULATION LIFE SYSTEM OF RICE LEAF ROLLER (*CNAPHALOCROCIS MEDINALIS* GUENÉE) Xue-ti Chen, Jia-rong Liang, Shu-fa Liu (Institute of Agricutturat Research Xuzhou, JiangSu Province 221121, China)

From 1979 to 1988, a systematic analysis and research on the retationship between the population of rice leaf rotter (C. medinatis Guenée) and some ecotogicat factors in the rice region of Huaibei, Jiangsu Province, with the tife tabte of insects, showed that the key stage in insects' life and the key factors affecting the population were the early stage of the tarvae (1-3 instar) and predaceous enemies and meterotogicat factors respectively.

According to the characteristics of the occurence and damage of the pest in Huaibei region, taking the number of migrating moths in the key migration stage (21 July to 10 Aug.) of main damage generation (3rd generation) during 1979-1988 for the nucteus, a forecast equation is constituted as follows.

$$LnFNM1=7.1899+0.2162Ln(ARM)-0.0830WD1+0.0292ARQ+\sum$$

Then taking the facts of att stages of the pest as dependent variables, the number of the previous stage, natural enemies and meteorotogicat factors, etc. as independent variabtes, as constitute a forecast formuta of different stadiums of insects' tife. The results of forecasting were basicatty in correspondence with the comparison of field investigation data.

DIAMONDBACK MOTH--PLANT INTERACTIONS. Wei-jian Wu (Lab. of Insect Ecology, South China Agricultural University, Guangzhou, 510642, China), Jian-xiong Wu (Experimental Central, South China Agricultural University, Guangzhou, 510642, China)

Mustard oil glycosides are the signal chemicals leading diamondback moth, *Plutella xylostella* L. to oviposit and feed on a host plant (Thorsteinson, 1953; Gupta *et al.*, 1960). This paper was intended to focus on the following questions: (i) method to quantitative determination of isothiocyanate and thiocyanate in some cruciferous plants; (ii) relationships between levels of certain isothiocyanates and egg laid; (iii) the host range of diamondback moth; (iv) coevolution of diamondback moth and its food plants.

PRELIMINARY OBSERVATION OF DIURNAL FLIGHT OF ALATAE IN APHIS GLYCINES MATUS. Li-hua Lu, Rui-lu Chen, Yu-rong He (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Gongzhuling 136100, China)

A field observation of diurnal flight of soybean aphid, Aphis glycines, was carried out at Gongzhuling in July 1987.

The fluctuation of diurnal flight of summer population showed a bimodal flight curve without take-off at night. The temperature threshold for take-off was 18.0-19.0℃. The light threshold was about 1000-1350lux. The peaks of take-off flight activity of soybean aphid were between 07:00-08:00 and again between 16:00-17:00. The alatae which were mature and accumulated overnight took off, produced the morning peak when the temperature and light were high enough. The decline of take-off number at mid-day was caused by a lack of flight-mature alàtae and the depression of much high light intensity to take-off. Once the light intensity decreases, the flight-mature alatae took off and produced the second peak.

THE QUANTITATIVE ESTIMATION OF THE CONTROLLING FUNCTION OF WOLF SPIDER ON RICE LEAF ROLLER, CNAPHALOCROCIS MEDINALIS, USING THE PRECIPITIN TEST. Jianggiu Tang (Research Institute of Entomology, Zhongshan University, Guangzhou 510275, China)

This paper deals with a method, based on the investigation of the population density of wolf spider in rice fields and on the function responses of the predation in different volumes, the population dynamic of the wolf spider and the numbers of the 1-2 instar or the 3-5 instar larvae of rice leaf roller predated by 1 wolf spider were simulated.

On the other hand, the duration for a meal remaining detectable in the gut of the predator and the rate of positive reaction that wolf spider fed on rice leaf roller were measured by using the precipitin test.

If the transplanted date of rice seedling and the density of the rice leaf roller were known, we can quantitatively estimate the numbers of the 1-2 instar or 3-5 instar larvae of rice leaf roller predated by wolf in rice fields.

THE EFFECTS OF THE RICE VARIETIES WITH DIFFERENT RESISTANCE ON THE PHYSIOLOGICAL METABOLISM OF THE BROWN PLANTHOPPER, Nilaparvata lugens (Stal). Wu Zhongfu, Chen Deli, Zhao Shixi (Department of plant protection, Fujian Agricultural College, Fuzhou 350002, China)

This paper deals with the effects of the rice varieties with different resistance on the esterase isozyme, the carboxylesterase activity and the total carbohydrate quantity inside the body of adults and nymphs of the biotype 1, brown planthopper (BPH), Nilaparvata lugens (Stal). The results showed that there were obvious effects found in the rice varieties with different resistance on the esterase isozyme, the carboxylesterase activity and the total carbohydrate quantity of BPH. The zymograms of the esterase isozyme of BPH nymphs from 1st instar to 5th instar, feeding on the rice varieties with different resistance, showed distinct three types of changes. The band B and C were found in those feeding on resistant varieties, the band A and C found in those feeding on middle resistant varieties, and the band B, C and A found in those feeding on susceptible varieties. The carboxylestrase activity in BPH adults feeding over 12 days and in BPH nymphs from 1st instar to 5th instar on resistant varieties were significantly lower than those on susceptible varieties. The total carbohydrate quantity of BPH adults and nymphs feeding on resistant varieties were also significantly lower than those feeding on susceptible varieties. This indicated that there was obvious retardation in the carboxylesterase activity production and the total carbohydrate accaumulation of adults and nymphs of BPH feeding on the resistant rice varieties. Our studies showed that there were no regular changes between the esterase isozyme and the carboxylesterase activity of the rice varieties with different resistance, and no relative effects of the esterase of rice varieties with different resistance on the isozyme inside the body of BPH.

PATH ANALYSIS ON FORECASTING MODELS FOR YELLOW RICE BORER. Zhao Shixi, Wu Zhongfu (Department of Plant protection,Fujian Agricultural College,Fuzhou 350002,China)

The previous data on the occurrence of yellow rice borer and historical records of meteorological elements over the past successive years 1972-1988 were analysed by correlation studies on influencing factors. The model of forecasting population for the second generation of the pest was established on the basis of stepwise discrimination analysis. It revealed that forecasting factors for the population were as follows:rainy days during the first ten days of March (X_1),average relative huminity during the second ten days of February (X_3),temperature-humidity coefficient during the second ten days of March (X_4) ,meteorological index during the second ten days of March (X_5) , meteorological index for March (X_8),survival population for the first generation of the pest in the fields(X_8) , and damaging rate for the first generation of the pest (dead hearts X_9) . Path analysis indicated that in forecasting system for populations of the second generation of the pest the determinative coefficient R^2=0.9953. It explained that 99.53% of prediction value were determined by all seven factors in the model and only 0.47% of that were determined by unknown factors. All unconsidered factors were known as surplus factor E and the path coefficient Pe=0.0684. The discrimination rate in the predicted model reached 100% through examination on former data. Practical use of the model during 1989 and 1990 had verified the consistency between theoretical grades for forecasting and grades representing actual population densities. Path analysis demonstrated that composition and construction of predicted factors for the second generation of yellow rice borer in the model could meet needs for prediction.

STUDIES ON THE EQUIVALENCE INJURY SYSTEM AND THE COMPLEX CONTROL THRESHOLD OF MAIN LEAF-EATING PESTS OF SOYBEAN. Yao -xun Qu,Zhen-quan Ma,Xiao-hua Gao,Xiang-ying Zou(Huimin Institute of Agricultural Science,Binzhou,Shandong 256615, China),Ji-yuan Mu,Shao-min Mu(Agricultural University of Shandong,Taian,Shandong 271018,China)

Clanis bilineata Walker,Plusia agnata Stanginger,Heliothis armigera Hubner and Plebejus argue L.occur complexly with different larval instars in Huang Huai soybean region.By making experiments with cutting leaf the correlated formula of the soybean yield reduction(Y)and the rate of leaf loss(X)were established:Y=38.9087+23.9701 lnX,at the stage of nutrition; Y=66.4818+42.6374 lnX,at the stage of reproduction.The eating leaf quantity per day of every larval instar of the four pests was determined,their correct coefficients of equivalency injury calculated,and the equivalency injury system was established.The economic injury level(EILt)at different developing stages was calculated.Using the correct coefficients of equivalency injury and the latent eating leaf quantity of the standard species in it's whole life(Ii),the EILt was converted into the economic injury level(EILi).Considering the varied factors,such as natural enemies etc,and using each species of the four pests as the standard species,the complex threshold was determined.

EXPERIMENTAL POPULATION PARAMETERS FOR THE SPIDER (Oedothorax insecticeps). Zhao Shixi,Wu Zhongfu (Dept.of Plant Protection,Fujian Agricultural College, Fuzhou 350002,China)

Some ecological characteristics including development duration, survival rate, multiplication dynamics,functional response and interative response of Oedothorax insecticeps were observed under different conditions of temperature. Parameters K,a and b of Logistic equation were examined through the models of the spider's deveolpmental rates during the egg stage, each of the young stages and the whole generation. According to the reseach on multiplication dynamics the fecundity specific life table of the experimental population was constructed and all the parameters were measured such as net reproductive rate, mean generation time, innate capacity of increase, finite rate of increase and doubling time. Based on the life table the stable age composition of the experimental population was constructed and its parameters were measured. In the light of analysing stable age composition of the experimental population Leslie matrix model was used to simulate its dynamics and population growth models were established. Through observations of predatory amount of the spider on white backed rice planthoppers Holling's functional response models were developed to explained the attack of female and male adult spiders on the pest during various instars of nymphae and adults. Simultaneously the variation of parameters (instantaneous attacking rate a', handling time Th and maxmium theoretical predatory amount max Na) was analysed. Two major parameters of interactive response were obtained through observations of spider's experimental population on individual interactive response. It turned out that there existed no significant variation between female adult spiders and male adult spiders in individual interactive response.

STUDIES ON BIOLOGY, ECOLOGY, PROTECTION AND USE OF SYRPHUS COROLLAE FABRICIUS. Fengcai Yang, Xueming Mo (Plant Protection Station of Yantai, Shandong Province 264001, China)

Syrphus corollae is one of the dominant species of the dominant species of the natural enemy of wheat aphids. The research was carried out in 1981-1988. The results are as follows: It reproduces five generations a year. The development periods of the egg, larva, anterior pupa, pupa and adult are 3, 7. 19, 1.03, 7.02 and 4.67 days respectively, at 1.82-22.8℃. The first, second and third instar larvae eat about 3.75, 16. 59 and 378.79 aphids, respectively. The reaction of larva eating function shows a negative acceleration curve. The models are got by means of Holling's (1959). II formula. The respective models are as follows: The first instar larva: Na=0.1753 Nt/1+0.01238 Nt; The second instar larva: Na=0. 2184 Nt/1+0.05508 Nt; The third instar larva: Na=0. 3543Nt/1+0. 0394Nt; The aphid-eating rate will decrease if the quantity of aphid-eating insects increases. Using M. P. Hassells, the formula is obtained as follow: $E=0.3909P^{-0.1181}$ (r=0.9439). The indicators of protection and use in 500-600 aphids/100 plants and the fly/aphid rate is below 1:80 in the flowering and milk periods of wheat.

PREDATION OF HARMONIA AXYRIDIS ON CHAITOPHORUS POPULIALBAE Fang-qiang Zheng, Zhao-hui Li, Bao-hua Yie, Deng-zhu Qi, Ai-min Li (Department of Plant Protection, Agricultural University of Shandong, Taian, Shandong, China 271018)

Laboratory studies show that the functional responses of 1-4 instar larvae and adult of Harmonia axyridis to wingless adult aphids of Chaitophorus populialbae belong to Holling II type and the models are

First instar larva	Na=0.6595N/(1+0.04688N)
Second instar larva	Na=0.7034N/(1+0.01440N)
Third instar larva	Na=0.7964N/(1+0.01170N)
Forth instar larva	Na=1.0211N/(1+0.009422N)
The adult	Na=0.9868N/(1+0.006837N)

The relationship between searching efficiency(E) and density of the adult (P) is described by Hassell & Varley's model $E=QP^{-m}$ and Beddington's model $E=aT/\ 1+bt_w(P-1)$,resulting in $E=0.4286P^{-0.6555}$ and E=0.4108/ (0.6288+0.3712P), respectively. Both models demonstrate that the searching efficiency declines with the increase of the ladybird density, but Beddington's model can described the relationship better than Hassell & Varley'S model.The relation of searching efficiency (E) to the adult ladybird density(P) and the prey density (N) is described by Beddington's model $E=aT/\ 1+at_hN+bt_w(P-1)$ and gives $E=0.4108/(0.6288 + 0.002846N + 0.3712P)$, i.e. the searching efficiency declines when the adult ladybird and prey densities increase.

SUTDY ON CONTROL INDEX OF SECOND GENERATION ARMYWORM, SPACIAL DISTRIBUTION OF LARVA, AND SEQUENTIAL SAMPLING TECHNIQUE. Wenkuan Mao, Yueju Jiang, Jianqiang Zheng , Xiaohua Zhang (Yantai Plant Protection Station, Yantai, Shandong 264001, China), Binzhi Zhan, Yuqin Cheng, Yuanqing Wang (Laizhou Plant Protection Station, laizhou, Shandong, China, 261400), Kezheng Bi, Shanmin Yan (Wendeng Plant Protection Station, Wendeng, Shandong 264400, China)

The experiments have been studied since 1983. It showed there was a positive correlation between the extent of the loss caused by the second generation armyworm and the larval population. The economic threshold index of the permissible was defined as the loss of about 4% of the yield, whlie the maiye yield was at the of level 400kg/mu. The proposed control index of the larval population: 40 per 100 plants at the four-leaf stage with one central leaf, 80 per 100 plants at six-leaf stage with one central leaf, and 30 per m a in the wheat field. The distribution type in space in the peak period of third instar shows negative binomial distribution. The test of the index in the six-term aggregation showed the strong aggregation of distributing in the third instar. "The check table of maximam theoretical sampling quantity (EN) "limtated provided important parametrers for working out the decision to control the second generation armyworm.

STUDIES ON THE SPATIAL DISTRIBUTION PATTERN AND THE ECONOMIC THRESHOLD OF TETRANYCHUS VIENNENSIS ON APPLE TREE. Zuo-xing Chi, Qing-xia Lu, Zhao-hong Li (Plant Protection Station of Taian Suburb, Taian, Shandong, China 271000)

The spatial distribution pattern of Tetranychus viennensis on apple tree were determined by six indices of aggregation, it belong to aggregated pattern. The suitable sampling method is choosing 5 typical trees and 5 sampling point each tree in the lower part in eastern or southern direction, investigating 10 leaves each point, a total of 250 leaves, and calculating the number of the spider mites . The field experiment results of 3 years prove that the loss rate of apple yield (y) is positively correlated with the number of the spider mites on 100 leaves (x), $y = -0.1483 + 0.0003778x$ ($r = 0.9412$, p 0.001). According to the formula , the economic threshold of controlling the spider mites in May and June in an apple orchard yielding 750 kg / mu is that the number of adults and nymphs on 100 leaves is 450 or the damage coeffient is 0.8-0.9.

DISCUSSIONS ABOUT IWAO'S M*—M MODEL. Xing-ping Lan (Forest Pest Quarantine & Control Station of Guizhou Province, Guiyang 550001, China)

This paper has been discussed the range of the regression parameter of a value and its possessing biological content, in Iwao's m*-m model. If $\alpha = m_1^*$, the crowding mean of individing in elementary component part of insect populations, then according to the definition and the computer formula of m_1^* , they may prove that the a value is no below zero when the insects population density is over or equal zero that is the α being a nonnegative number. However, in practical application, sometimes α may be below zero, so this result is contracdictory with the definition of α. On this condition, it is not proper that explained individual habit as reciprocal exclussion. If α value is limitless, and α & β are regarded as general parameter of linear regression equation, then compose types of α and β are nine in the m*-m right angel coordinate system. Four new compose types of α and β are presented on the basis of above states by author. As relationship between m* and m is inear, variety of compose types of α and β can provide different information about spatial distribution pattern of insect population.

THE INVESTIGATION OF ORTHOPTEREN COMMUNITIES IN THE SUBURBS OF JINAN. Yu-zhen Lin, Rong-shu Fu (Department of Biology, Shandong Teachers' University, Jinan 250014, China)

This paper, based on the environmental humidity conditions, classifies the biotope in the suburbs of Jinan into drought, sub-drought, sub-moist and moist. The systematic investigation for Orthopteren communities in the 4 habitat forms has been done. The results show that the Orthopteren communities among these different habitat forms are quite different. The Orthopteren species in the drought and sub-drought habitat forms are much more than the species in the moist and sub-moist habitat forms. Trilophidia annulata, Oedaleus infernalis, Calliptamus abbreviatus and Sphingonotus mongolicus can only live in the drought habitats and be regarded as the characteristic species in the drought habitat form; Oxya chinensis, O. velox, O. hyla intricata, Shirakiacris shirakii and Epacromius coerulipes can only live in the moist habitats and be regarded as characteristic species in the moist habitat form. In addition, the author points out that Atractomorpha sinensis and Acrida cinerea are the typical euryoecious species in this region. Oxya chinensis is the dominant species in the low-lying moist habitats. It is necessary to make a further study for them. Locusta migratoria manilensis (solitary) can be found in all the 4 habitat forms, to which we must pay much attention to study them.

EVALUATION ON VARIETAL RESISTANCE OF RICE TO THE BROWN PLANTHOPPER. Chun-xian Gao, Yawei Bei and Xiu-hui Gu (Institute of Plant Protection, Zhejiang Academy of Agricultural Sciences, Hangzhou 310021, China)

The paper describes the results from the evaluation on the resistance of Japonica varieties to the brown planthopper (BPH) . Nilaparvata lugens. The rice variety Xiu-shui 48 was used on susceptible control. 1) Effects of antibiosis: The amount of honeydew excreted by BPH was apparently greater on susceptible than that on resistant varieties. The number of eggs oviposited in the life-span of BPH as reared on different rice varieties were: 316.2/female on Xiu-shui 48; 191.0/female on Xiu-shui 620; 165.2/female on Jia 23 and 87.5/female on IR64. The survival rates of BPH as reared on different rice varieties were: Xiu-shui 48, 100%; Xiu-shui 620, 44% and Jia 23, 28.22%. 2) The rates of population increase of N. lugens as reared on different resistant varieties were 0.122 on Xiu-shui 48; 0.088 on Xiu-shui 620 and 0. 083 on Jia 23-2.3) The K values of logistic models on the tested varieties were: Xiu-shui 48, 81.58 and Xiu-shui 620, 30.54. 4) The intrinsic control rate in this experiment was Xui-shui 48, 0; Xiu-shui 620, 78.29% Jia 23, 84.94% and IR64, 86:32%. 5) The field control rates by using of several varieties over N. lugens were: Xiu-shui 48, 0; Xiu-shui 620, 77.23% and Jia 23-2, 76.68%

RESEARCH ON REGULARITY MIGRATION OF CABBAGE APHID BREVICORYNE BRASSICAE (L.) Zhonglian Lai (Guizhou Agricultural Academy of Science, Guiyang 550006, China) Hong Lai, Jingao Wu, Guoqiang Zhou (Huaxi District Agrotechnical School, Guiyang 550025, China), Hongchang Zhang, Guishu Cheng, Lingxia Long, Weihong Jin, Zhengfen Wu (Guiyang City Vegetable office, 550003, China), Qinghuai Luo (Guiyang Agricultural Institute of Science, Guiyang 550018, China)

The authors studied on Brevicoryne brassicae in Guiyang for more than ten years. Overwintering insects weren't found on cruciferous vegetables and field weeds. However, in spring, winged adult suddenly added so high that it's on accord with local aphid situation and developing stage. That the winged adult of B. brassicae was directly inspected descended from air to vegetable. B. brassicae migrated out off from plant. After then, the amount aphid of decreased suddenly. When tempture from 13℃ to 20℃ , humidity 65-80%, illuminaton 2000-42000 Lux, in that clear day the migratory amount of the winged adult of B. brassicae is most. Normally the migration happened at 7-8 am, fewer at other time, didn't happen in the evening.

A PRELIMINARY STUDY ON THE VERTICAL DISTRIBUTION OF EGGS OF HYDRELLIA CHINENSIS QI ET LI IN HIGHLAND BARLEY FIELDS. Zuyin Jin, Zuojun Liu (Department of Biology, Northwest Normal University, Lanzhou 730070, China). This paper reports the vertical distribution of eggs of Hydrellia chinensis Qi et Li in highland barley fields during 1989-1990.

The results obtained indicate that the spatial distribution pattern of eggs on the 2nd to 4th leaf beneath the heart leaf at the top of highland barley belongs to an aggregated distribution pattern just as the whole plant's; the eggs are distributed mainly over the range between the 2nd and 4th leaf during the height period of eggs which is uninfluenced by different environmental fields and different growth periods; the rate of distribution ($\bar{P}_h$) and the estimation of the confidence interval ($\hat{P}_h$) of the ammount of eggs as follows:(95% confidential degree)

$\bar{P}_{2.3.4}$: 90.26%, $\hat{P}_{2.3.4}$: (87.39%, 93.12%)
$\bar{P}_{3.4}$: 74.06%, $\hat{P}_{3.4}$: (71.97%, 76.16%)
$\bar{P}_{2.3}$: 59.22%, $\hat{P}_{2.3}$: (53.81%, 64.63%)

It is suggested that we only need to examine the eggs on the 2nd and 3rd or 3rd and 4th leaves during the height period of eggs to make an inference for the range of the total eggs of the whole field according to the estimation. It is possible that 1/2 field working load can be saved.

THE INFLUENCE OF GREENHOUSE EFFECT ON INSECTS ECOLOGY FEATURE.
Li Shuhua (Agrometeorological Institute, Chinese Academy of Agricultural Sciences, 30 Baishiqiao Road, Beijing 100081, China)

The greenhouse effect would greatly influence on insects major ecology feature. The pollution of low concentration of SO2 also effects on the breeding and developing rate the insects. Moreover, both of the climate change and the increase of accumulated temperature make the insects not only incease breeding generation, but also move northward of hibemalisation demarcation line and expand the area of the insects fright. Therefore, the climate change would cause the time prolonging and more serious of insects harming crop.

ECOSYSTEM OF PADDY FIELDS AND THEIR IPM. Chang-ming Chen (Laboratory of Insect Ecology. Hunan Agricultural College. Changsha.410128.China)

The paper reported that the results of research in this title had been carried out in Changsha. 1980－1990. The characters of ecosystem are analysed by their structure and function.Between the rice／pests／natural enemies.there are both inevitable relations and artificial distruptions. The simulations of the population dynamics of rice. main pests and main natural enemies were developed. The energy flow of ecosystem of rice fields were determined. The experments concerning the predation.the dynamic economic threshold and the measures of rice pests control were studied. Based on above mentioned simulations and experiments.in light of the holitic ecosystem. a flow chart of management system of the rice pest was suggested. In the flow chart the decision making process was distinguished into tendency and real time decision making. merging pest prediction and control in harmony and attempting to conduct the optimal management of insect pests.

STUDIES ON BIONOMICS AND ANNUAL POPULATION DYNAMICS OF THE COCONUT SCALE. Cheng-ai Zhou, Jian-ju Zou(Hunan Horticultural Research Institute. Changsha 410125, China)

The coconut scale (Aspidiotus destructor Sign.), one of the major pests on kiwifruit, occures 3 generations in Hunan each year. Its female adults overwinter on trunk and begin to oviposite in early and middle April, the ratio of female to male is 1:1.04 , each female lays 32. 17–42. 11 eggs. Under laboratory condition, the mean duration of the eggs reqired 5 days to hatch, the young body lasted 17 days, the preoviposition period averaged 24.7 days. The life cycles of females and males were 44. 1 and 347. 5 days respectively. The development threshold temperature of female and male are 10. 49 and 8.63℃ , the effective accumulated temperature were 755. 89 and 727.60 day degrees separately. The damaged degree of fruits of Actinidia chinensis Planch was more serious than that of A. chinensis var. hispida C. F. Liang. Through studies on annual population dynamics and life table of natural population is 1989–1990, a type I survivorship curve of the Weibull frequency distribution was inferred for each generation data sets mortality rate increased with increasing age, the major factors influencing the population dynamics of the generation were female death, the 2nd instar death and female parasited by Aphysis sp.. The index of population tendency (I) decreased gradually in a year. The damage by the scale in unspraying orchards can be controlled under control level by integrated action of death factors.

STANDARD TEMPERATURE SUMMATION RULE(STSR) . Huming Li(Department of Biology, Jishou University, Hunan 416000, China), Changshan Lin (Department of Biology, Peking University, Beijing 100871, China)

It is found that there exist limitation and inaccuracy in the practical application of the effective temperature summation rule (ETSR) which is necessary to be improved. In this paper, we present an idea that the criterion of the insect development is not the summation of the temperature above the lower threshold but the accumulation of standard temperature. Based on the model of insect development rate (Li & Lin, 1986) , a mathematical formula for calculating the standard temperature is given as follows:

$$Tsi = \frac{2To(Ti-Tn)\exp[(To-Ti)/(To-Tn)]}{(To-Tn)\{1+\exp[r(To-Ti)^2]\}}$$

Tn=TL, r=a, when Ti< To; Tn=TH, r=b, When Ti>=To;

Where, TL and TH are the lower and upper threhold temperatures respectively; both a and b, constants; To is the optimum temperature; Tsi, the standard temperature of observed temperature Ti. Thus, the STSR can be ecpressed as : Ks=Tsi Hi. Here, Ks is the total number of the standard temperature for an insect to complete its development; Hi, the time zone which the insects undergo at standard temperature Tsi. The accuracies of simulation and prediction of STSR are much higher than those of ETSR.

THE HORMONICS THEORY OF INSECT MIGRATION. Changshan Lin (Department of Biology, Peking University, Beijing 100871, China)

Insect migration is a complicated phenomena, but it is not an isolated phenomenon. From ontology point of view, any matter in the whole universe is not a pile of orderless straws, but rather a system of structured organization of interrelated subsystems, forming a united systems, therefore, first of all it is necessary from system point of view to have a deeper comprehension of phenomena of insect migration. The primary theoretical goal is the founding of a system. Once it forms a system, further approach from this angle, a deeper comprehension of insect migration is thus possible. The second premise: the real system is different from each other. Since it is a system, it is thus possible to use a general theoretical scheme to entranch the understanding of each regularity. It is safe to say that migration of insect is composed of three important essentials: the component (C), the environment (E) and the structure of function (S). Thus any kind of insect migration can be analyzed either completely or partially but the analysis is not final. It can be further supplemented, completed or revised. The third premise: any branch of science or artificial system (technology), even it may be safe to say that the majority of science study is nothing else except studying of a system. Using the analogy to illustrate the importance of hormonic action of insect migration, the armyworm moth migration can be expressed in the following model: Ma< , t> = <C(, t), E(, t), S(, t)>. This model can categorically state that adult moth migration (Ma(, t)) is a set of component (C), environment (E) and structure (S) of system at t time as a result of hormonic action.

THEORETICAL ANALYSIS OF PREDATOR - PREY SYSTEM MODELLED WITH OPTIMUM REGRESSION DESIGN Yun-long Xia, Ke-xun huang (Department of Plant Protection, Beijing Agricultural University, Beijing 100094, China, Yu-yuan Guo (Institute of Plant Protection, Chinese Academy of Agricultural Sciences).

In this paper, a theoretical analysis method of prey-predator system modelled with optimum regression design was proposed, including the types of curve surface, standardization of regression equation and explanation of the biological significance, etc.. Six parameters for depicting the system, namely, the predation threshold, least density for predation, predation index, potential of predation, coordinated developmental ratio of population and control index were defined. This method is also of use for illustrating the other regression models.

STUDY ON THE HORIZONTAL AND VERTICAL DISTRIBUTION PATTERNS OF TWO DIMENTIONS OF APRIONA GERMARI IN NORTH CHINA. Dazhuang Huang, Yehui Yan, Zhigang Wang, Dianrong Ji, Junjie Yan (Hebei Forestry College, Baoding 071000, China)

Apriona germari is a dominent population which seriously damaged day by day in complex forest trees, fruit trees, mulberries ecosystem in North China. The aim is that objectively recognizing its horizontal and vertical distribution patterns so as to provide guides for designing Integrated Pest Management measures. Its spatial distribution patterns almost tended to gregarious distribution by systematic sampling and surveying statistics of 5390 sample plots in Populus tomentosa stands of different diameter grads, forest forms and ecological environments. 2cm as unit of diameter grade, 2m as a section, by the big sample statistic analysis of 160 trees. It was showed that the distribution height of insect tunnels in trees below 24cm breast diameter was positive correlation with diameter grade; The average height below 12cm was within 8m; The height between 12-24cm was 8-14m; The height above 24cm was stably 15-18m. It was suggested that the control should focus on the damaged trees below 12cm breast diameter in order to guarantee insect tunnels was absent within 6.3m high main trunk.

INTRASPECIFIC LARVAL COMPETITION IN CALLOSOBRUCHUS ANALIS (FABR.) BRUCHIDAE: COLEOPTERA).- UMESH BHARTI, 324, SECTOR - 22A, CHANDIGARH- 160022 (INDIA)

The competition for survival amongst two larvae developing in one seed of Vigna radiata was studied in detail. The competition was observed between larvae of different ages, and larval and prepupal/pupal stage. The aggressive behaviour of the surviving larva was seen and injured bodies of the defeated larvae were found in the seed. The stage at which one of the two larvae was eaten, depends on the relative distance between the two eggs on the seeds and age of the developing larvae.The larvae which were able to survive during the competition and were able to successfully emerge as adults were: stronger one of the same age, senior in age and of more active developmental stage. Whatever the case may be only one individual is able to continue further developmental process to emerge as adult. This behaviour of competition between larvae reduces the prospects both of survival and of maximal reproduction by mechanism of natural selection. The various aspects which were studied for intraspecific larval competition in Callosobruchus analis (Fabr.) will be discussed in detail.

THE SPATIAL DISTRIBUTION PATTERN AND SEQUENTIAL SAMPLING FOR THE POPULATION OF RAPE APHIDS IN SEEDLING STAGE OF RAPE. Shao-you Liu, You-ming Hou (Depart. of Plant Prot., Northwestern Agri. Univ., Yangling, Shaanxi 712100, China), Zuo-dong Hu, Jian-you Wang (Qian county Station of Plant Prot. and Quar., Shaanxi 713300, China), Yao-dong Dong (Yangling Station of Plant Prot. and Quar., Yangling, Shaanxi 712100, China)

In present paper, the spatial distribution pattern of rape aphids in seedling stage of rape is studied by aggregation index($m / \bar{x}$), S^2 / x, index of clumping (I), Iwao's method of regression of mean crowding (m) on mean density ($\bar{x}$) and the Taylor's power law from data obtained in Qian county, Yao county and Yangling, Shaanxi province, All indexes indicate that the spatial distribution pattern for rape aphids in the seedling stage of rape is the aggregation distribution. Two models of optimization sampling are obtained with the mothod of Iwao's regression of mean crowding (m) on mean density ($\bar{x}$) and the method of Southwood's Ke. On basis of these results, a table of Iwao's sequential sampling for various control standards and the diagrams of Green's sequential sampling for various accuracies are made out. One method of Iwao-Green compound sequential sampling of rape aphids is established with models of both Iwao and Green's sequential sampling. The compound model can reduce the number of the sample and raises the accuracy under some situation.

Key words: Rape; Rape aphid; Spatial distribution pattern; Theory sampling; Sequential sampling

FORECASTING MODEL FOR RICE STEM BORERS (SCIRPOPHAGA SPP.) (LEPIDOPTERA: PYRALIDE)

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Rice stem borers (Scirpophaga incertulas (Walker) and S. innotata (Walker) are serious pests of rice in South Asia. In Pakistan their population density, based on adult catches on light traps, has been monitored since 1976. Significant correlations were observed between the density of adults and the precipitation, maximum- and minimum- temperature. Low temperature and low rainfall during the borer diapausing stage (November-March) and high rainfall and high temperature during August-September, when the borers are developing on the main rice crop, favour their population build up. Multiple regression model has been developed to predict the densities.

FRACTALS IN INSECT SPATIAL PATTERNS. Bai-lian Li (Center for Biosystems Modelling, Department of Industrial Engineering, Texas A&M University, College Station, TX 77843-3131, USA)

Spatial pattern analysis in insect ecology is the quantitative description of the 2-D or 3-D distribution of individuals of a species within a homogeneous or heterogeneous insect community, where this distribution may be random, regular, or aggregated. Approaches to the analysis of spatial patterns originally centered on statistical tests of randomness, e.g. use of the Poisson distribution, and spatial indices based on scattered quadrats. However, many insect dispersion patterns are non-random, and the identification of pattern and these indices are themselves scale dependent. Mandelbrot's concept of a fractal extends our usual ideas of classical geometry beyond those of point, line, circle and so on into the realm of the irregular, disjoint and singular. Fractals represent many kinds of patterns, including density, diversity, geometrical shapes, and size distributions. It will provide us a new possible way to understand, analyze and simulate insect spatial patterns.

In this paper, I will introduce some concepts and methods of fractal geometry into insect spatial pattern analysis, such as, box-counting fractals, information fractals, statistical fractals, etc.. Fractional Brownian motion as modelling insect spatial distributions linking with image synthesis and geographic information systems (GIS) is considered in practice. From fractal point of view, mechanism of insect patch formation, ecological consequences of insect spatial fractal structure (the distribution of sizes of organism, the distribution of geographical ranges of organisms and the distribution of abundances in a insect community), and multiple scale sampling are discussed.

HOST EXPLOITATION DECISIONS: A LIFE HISTORY PERSPECTIVE. Bernard D. Roitberg (Behavioural Ecology Research Group and Centre for Pest Managent, Department of Biosciences, Simon Fraser University, Burnaby, BC, V5A 1S6, Canada)

Insects must make several "decisions" while searching for and upon encountering potential hosts. Each of those decisions (e. g. where to search, how long to search, when to accept)are generally treated separately by entomologists even though such decisions are part of the same overall process of host exploitation. In this paper I show how to link the various decisions together by use of a life history perspective and dynamic models. In doing so one can show how exogenous (e. g. host densities, seasonality, natural enemies)and endogenous (e. g. fecundity, information state, expectation of life) factors might be predicted to influence host exploitation decisions. Examples from two taxa: wasps and flies will be used to show how the theory might be applied in the laboratory and field.

LIMITS AND DYNAMICS OF ODOR LEARNING IN AN ENTOMOPHAGOUS PARASITOID. Daniel R. Papaj (Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona 85721, USA)

Most learning in insects adapts the individual to its current environment. This should be no less true of female entomophagous parasitoids that learn odors associated with host products or the microhabitat in which the hosts live. For a solitary endoparasitoid of *Drosophila* larvae, *Leptopilina heterotoma* (Order Hymenoptera: Family Eucoilidae), evidence is presented that a positive experience (i.e., egglaying)in a host microhabitat causes females in wind tunnels to orient preferentially to the odor of that microhabitat, while a negative or null experience (i.e., foraging unsuccessfully for hosts in a microhabitat) completely reverses the preference. A similar effect is observed with respect to time spent foraging in those microhabitats. A positive experience extends the time spent in the rewarding microhabitat; a negative or null experience reduces that time to almost nothing, while simultaneously increasing the time spent in microhabitats of novel type. I argue that these effects permit the parasitoid to track effectively changes in its environment and so are adapting. I also address a so called limit on learning, stimulus generalization, which appears at first glance to be maladaptive. I discuss how this widespread learning phenomenon can, in fact, be adaptive and evaluate evidence for or against with respect to *L. heterotoma.*

HOST SELECTION BY WHITEFLY PARASITOIDS. Dan Gerling, Orit Shimron (Tel Aviv University, Department of Zoology, Israel)

The role of precontact and post contact factors in molding the behavior of parasitoid females during host selection is examined.

Long distance attraction of the examined species to yellow color serves as a guide towards the plants. In addition, *Eretmocerus* is attracted to honeydew. Retention of females on a patch is due to honeydew modulated arrestment. It is an 'all or none' reaction in *Encarsia* and quantity dependent in *Eretmocerus*. Short distance searching is random (some *Encarsia, Eretmocerus*) or guided by leaf structure (some *Encarsia, Amitus*). Visual attraction occurs at a few mm. distance. Patch desertion in *Eretmocerus* occurs prior to parasitization of all suitable hosts on a patch.

Host examination and acceptance follows antennal drumming and often (*Encarsia*) or occasionally (*Eretmocerus*) ovipositor probing. Recognition of previously parasitized hosts by conspecifics has been shown in all cases except *Encarsia opulenta*. Recognition across genera was found in the latter only. Superparasitism is usually rare. Most *Encarsia* have autoparasitic males. Their females select immatures of other species, whenever available, for male development.

SEARCHING STRATEGY AND HOST SELECTION BEHAVIOR BY THE HETEROPTERAN GENERALIST PREDATOR *Podisus maculiventris*. Robert N. Wiedenmann, Department of Entomology, Texas A&M University, College Station, Texas 77843 USA.

The interactions between the search strategy, search behavior and life history of the predator *Podisus maculiventris* were studied in laboratory and field trials. In the field, attack rates at low prey densities remained nearly constant and averaged 0.5 attacks per day. Attack rates were used to infer search area, which showed an increasing amount of leaf area searched as prey density decreased. At high prey densities, attack rates increased linearly, consistent with predators searching a constant amount of area, independent of prey density. Laboratory observations verified that predators searched more area at low prey density than at high prey density and unsuccessful predators searched more area and more time than did successful predators. Laboratory observations also showed that predators did not use cues to find prey until immediately proximal to prey, did not search a restricted area after attacks and spent long periods plant-feeding or remaining motionless in a favorable microhabitat. Life history studies showed the predator responded to increasing time between feedings by maintaining survivorship at the cost of reproduction. The search strategy is appropriate for predators that minimize searching and metabolic costs, while maintaining prey encounters at a rate sufficient to meet reproductive demands. The search strategy, coupled with the lack of species-specific cues for finding prey, the lack of area-restricted search and the presence of plant-feeding are appropriate behaviors for a generalist predator that maintains a population in a crop habitat with prey that are encountered infrequently.

FORAGING BEHAVIOUR BY PREDACEOUS *CHILOCORUS NIGRITUS* (COLEOPTERA: COCCINELLIDAE). Vaughan Hattingh (University of Natal, South Africa)

Location of habitat, prey patch and individual prey, by *C. nigritus* (Mulsant), an effective biocontrol agent of diaspidid scale insects, was studied through laboratory experimentation. Vertically oriented lines were more attractive than horizontal lines. A simulated image of a horizon with a tree line was preferred to a flat horizon. Images of individual trees were also attractive. Simple ovate leaves were preferred to compound bipinnate leaves and squares. The location of prey patches was facilitated by prey odour for adults but not larvae. Adults detected individual prey visually and olfactorily over short distances but physical contact with prey was required for detection by larvae. Prey location by adults and larvae was facilitated by alterations in movement patterns in response to prey consumption and time since the last prey encounter. These results explain how effective shuttling between habitats in the field is achieved. Differences in foraging behaviour between larvae and adults, was associated with their roles in habitat selection. These results provide guidelines for improving their biocontrol value.

KAIROMONE/SYNOMONE-MEDIATED DISPERSAL BEHAVIOUR OF PHYTOSEIID MITES:ITS EVOLUTION AND CONSEQUENCES FOR POPULATION DYNAMICS. M. W. Sabelis (Department of Pure and Applied Ecology, University of Amsterdam, Kruislaan 302, 1098 SM Amsterdam, The Netherlands)

Whether dispersal is ambulatory or passively by wind currents, the underlying behaviour of plant-inhabiting predatory mites (Acari: Phytoseiidae) is strongly influenced by chemical cues associated with their prey, phytophagous mites such as spider mites and rust mites. An important category of these chemicals is both volatile and of plant-origin. They are released from the plant not until after infestation by phytophagous mites. Upon perception by predatory mites they may give rise to a variety of take-off behaviour. These chemicals provide information on prey quality and prey quantity, the precision of which seems quite high, though exceptions are known and more work is needed. Hypotheses on the evolution of plant/prey produced chemical information (kairomones/synomones) and of the behavioral responses to these chemicals are provided. In addition potential consequences for predator-prey dynamics are discussed by reviewing inferences from analytic population models.

PHEROMONES FOR THE CONTROL OF COTTON PESTS IN DEVELOPING COUNTRIES. L. J. McVeigh, (Natural Resources Institute, UK.)

The Natural Resources Institute has developed the use of pheromones forcotton pest control and monitoring in a number of countries in the developing world. These studies have led to the use of pink bollworm pheromone on a commercial basis in Egypt as part of the standard cotton pest control strategy. Other trials have demonstrated the potential for the control of the Egyptian cotton leafwrom using its pheromone. Work in Pakistan has shown that three formulations of pink bollworm pheromone can be integrated with conventional pesticides in a package to control the entire cotton pest complex. It has also been established that two other bollworm pests can be controlled by a single application of the main component of their pheromones. Recent cooperative work in China has indicated that pheromonal control of pink bollworm in Chinese cotton is possible using hand applied pheromone formulations. Research in South America has led to the development of monitoring systems for a number of cotton pests in Peru, Paraguay and Barbados.

CONTROL OF PINK BOLLWORM BY MATING DISRUPTION. Kinya Ogawa (Shin-Etsu Chemical Co. Ltd., 6-1 Ohtemachi, 2-chome, Chiyoda-ku, Tokyo,Japan)

We and our co-researchers have conducted tests of mating disruption on more than 40 species of Lepidoptera. We have gotten rather good results in most cases. Eleven products have been registered in several countries. The important factors influencing the efficacy of mating disruption are as follows.

1. Population density of target insects.
2. Area size.
3. wind.
4. Timing of application
5. Pheromone concentration

We would like to discuss the above factors using the case of *Pectinophora gossypiella*. In USA, the whitefly problem has become very serious. No effective measure to control it has been found. Only a reduction of chemical sprays and the use of pheromone against other insects can control the whitefly with the aid of its natural enemies. This is the most advantages of pheromone use.

MANAGEMENT OF FIELD AND VEGETABLE CROP INSECT PESTS WITH SEMIOCHEMICALS: OPPORTUNITIES AND CONSTRAINTS. E.R. Mitchell (USDA-ARS, Research Laboratory, Behavior Ecology and Reprod. Unit, 1700 SW 23rd Drive, P.O. Box 14565, Gainesville, Florida 32604, USA)

Insect sex pheromones and other semiochemicals are receiving increased scrutiny as possible alternatives or adjuncts to conventional pesticides for management of several key pests of field and vegetable crops. The renewed interest in this technology is prompted by increased pest resistance to conventional insecticides, changing attitudes on the part of growers, consumers, and governmental agencies, and the advent of improved and new formulations for disseminating semiochemicals in cropping environments.The impact of chemical disruptants on mating by Heliothisspp., Spodoptera frugiperda, and diamondback moth (Plutella xylostella) will be presented.

THE POSSIBLILITY OF APPLYING GOSSYPLURE TO CONTROL THE PINK BOLLWORM (PECTINOPHORA GOSSYPIELLA SAUNDERS) IN CHINA CHI-YANG CAO (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences, Nanjing 210014, China)

Gossyplure has been applied to control the pink bollworm in cotton regions along the Yangtze River in past ten years. Both moth trapping and mating disruption methods have been used in different areas with various degree of success. For extending use of this new technology of control several requirements should be well discussed.
1 The character of pink bollworm distribution in various cotton regions should be mentioned. In the low or middle population level area moth trapping as well as mating disruption with low dosage of gossyplure can be achieved while in the high population level area a higher dosage of gossyplure for mating disruption is needed.
2 The working area of gossyplure should be no less than 4 hactares which could be achieved without isolation.
3 Since gossyplure is a high selective material which control the pink bollworm only so it should be integrated with other pesticides to control the pests other than the pink bollworm, the monetary input for applying gossyplure must be lower than that of applying other pesticides for controlling the pink bollworm.
4 Training is necessary for both the technicians and farmers.
5 The data of gossyplure experiments in various forms of application are presented showing lower damage of green bolls, less living larvae in seed cotton, higher quality of cotton and less input of pesticides and labors.

PRESENT STATUS OF SEX PHEROMONE·APPLICATION IN PEST MANAGEMENT IN JAPAN. Sadao Wakamura (National Institute of Sericultural and Entomological Science, Ohwashi 1-2, Tsukuba, Ibaraki 305, Japan)

Synthetic sex pheromone has been intensively evaluated as a sampling tool for population monitoring and as a pest management agent of many Lepidoptera and Coleoptera crop pests in Japan. Sex pheromone formulations and trapping devices are commercially available for 20 pest species of field crops and 3 pest species of stored products. Mass trapping devices for population management are also commercially available for an armyworm, Spodotera litura, and an elaterid beetle, Melanotus okinawaensis. M. okinawaensis, a serious Okinawan sugar cane pest, was reduced by mass trapping of males year after year. In this species, males become active to synthetic sex pheromone about one month before females begin to release sex pheromone. Communication disruption has been most intensively evaluated in several pest species of vegetable, fruit and tea plants. A large supply of an unique formulation of synthetic sex pheromone, in which pheromone is sealed in and released from polyethylene tubes, enabled us to evaluate and confirm the effect in the field. Pest species with commercially available synthetic sex pheromone formulation are: diamondback moth (Plutella xylostella), beet armyworm (Spodoptera exigua), cherry treeborer (Synanthedon hector), peach fruit moth (Carposina niponensis), summer fruit tortrix (Adoxophyea orana fasciata), a tea plant tortricid (Adoxophyes sp.), and oriental tea tortrix (Homona magnanima). Sex pheromone has been used as an alternative tool, especially against insecticide-resistant populations.

EFFICACY AND LIMITATION OF GOSSYPLURE FOR CONTROLLING AND MORNITORING PINK BOLLWORM IN CHINA. Yuan-guang Chen, Li Zhang, Jia-long Xie (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China)

A new Type of formulation, Laminated Plastic Capsule (LPC), has been created for depressing and monitoring Pink Bollworm (PBW) population. Tests were conducted in Chanjiang River Valley in China from 1983 to 1989. Only 70% cotton fields where the Fequnecy of mean catches/trap/night over 100 males are below 3 times during flying season, the mating disruption method can be used as one of the effective measures in IMP to supress PBW population below enconomic threshold. A range of 25-50% decrement of pestisides in Gossyplure treated plots depends on PBW density and abundance of other pests. Water trap baited with a LPC lure contained 1 mg Gossyplure could be 30-days effective to monitor dynamic of PBW population. Accumulated male catches before moth peak of 1st Gen., date of squaring,and total rainfall from mid-June to early-July are operated as parameters to build model by method of Fuzzy Synthetical Evaluation with computer aided. Since the uncertainty and fuzziness of parameters, the Fuzzy Model is more accurate, convenient and informative than the model of Multiple Linear Regression for estimating mean egg counts in 2nd Gen.. A practical Quick Index Table based on Fuzzy Model is Provided.

ASSESSING THE POTENTIAL OF USING PHEROMONE/VIRUS COMBINATIONS FOR INSECT CONTROL. Jia-wei Du (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China).

Three basic studies have been conducted to investigate the potential of using a virus-dispersal technique for controlling agricultural and forest pests. One study centered on the transmission of the virus a) to males attracted to virus-contaminated pheromone lures, particularly in relationship to the male's random movements and hairpencil displays on the lure, and b) to the eggs after mating occurs with virus-infected males. A second study followed the transmission of virus to offspring of *Heliothis armigera* parents that contained a sublethal infection of the virus. The third study involved the collection of data on the epidemic spread of virus in a population with a sublethal virus infection and its potential for use in suppressing pest populations.

Research efforts now are underway to assess the efficacy of this technique in the field and to develop operational strategies for its use in insect control programs.

MONITORING AND CONTROL FRUIT TREE PESTS BY SEX PHEROMONE SYSTEMS IN NORTH CHINA. Meng-ying Liu(Institute of Zoology, Academia Sinica, Beijing 100080,China)

In North China several insect pests of fruit trees, such as apples, pears, peaches, chestnuts as well as red dates, often cause a great loss of fruit production. Chemical pesticides have been applied intensively for gaining better production. Since 1970's insect sex pheromones of several pests have been synthesized and studied. Pest monitoring techniques with pheromone traps have been developed. The sex pheromone monitoring systems have been extended to large area, and great benefits have been resulted. Experiments by using sex pheromone for direct control of Carposina niponensis, Grapholitha molesta, Dichocrocis punctiferalis and Acylis sativa have been conducted with success.

STUDIES ON THE APPLICATION OF THE SEX PHEROMONE OF ORIENTAL FRUIT MOTH, GRAPHOLITHA MOLESTA BUSCK. Xian-zuo Meng(Institute of Zoology, Academia Sinica, #19 Zhongguancun Lu, Beijing 100080, China)

The population monitoring system using the sex pheromone of the Oriental fruit moth, Grapholitha molesta Busck, has been extended to large fruit growing areas in 18 provinces in China. The trials for the direct control of the pest with the sex pheromone mass trapping have succeeded in large scale. In the mass-trapped areas, the female mating rates were 74.2-82.9% lower, the rate of eggs parasitized was 79.2% more, and the fruit damage rates were 50.3-72.8% less than those in the chemical control areas. Mating disruption of the insect by using the sex pheromone was also tested and the results were satisfactory. The disruption percentage of male orientation was 97.2% to synthetic pheromone baited traps, and 100% to female-baited traps. In the disruptant areas, the female mating rates were 73.6-88.3% lower and the fruit damage rates were 39.7-74.9% lower than those in the chemical control areas.

DEVELOPMENT OF THE FORMULATION OF SEX ATTRACTANT AND TRAP SYSTEM FOR CARAMBOLA FRUIT BORER, EUCOSMA NOTANTHES MEYRICK. Jenn-sheng Hwang, Chau-Chin Hung (Taiwan Agricultural Chemicals and Toxic Substances Research Institute,Wufeng, Taichung, Taiwan 41301,China)

The synthetic sex pheromone, z-8-dodecenyl acetate, of the Oriental fruit moth, Grupholitha molesta(Busck) could mostly attract the male moths of Eucosma notanthes Meyrick in carambola orchards. Trapping data showed that 0.5 - 1 mg of z-8-dodecenyl acetate on a rubber septum was more attractive and inexpensive than other formulations. The attractancy of this sex attractant was equivalent to that of 4 virgin females, and it remained effective for 6 - 8 months in the orchard. The three layers and funnel type PET bottle trap with 16 opening of 0.8 cm hung on the tree's branch 150 ~ 200 cm above the ground was more effective and ease to use for trapping male moths than any other designs. The possible application of the sex attractant in monitoring and mating disruption of E. notanthes was also studied and will be discussed.

CONTROL OF CODLING MOTH (CYDIA POMONELLA) VIA PHEROMONE TREATMENTS TO DISRUPT MATING (LEPIDOPTERA: TORTRICIDAE). J.F. Howell (U.S. Dept. Agric. retired, now Superior Ag Products Inc. P. O. Box 8284, Yakima, Washington, USA)

A 3-component blend of products identified as components of the codling moth sex pheromone dispensed via polythylene rope ties provided by Biocontrol Ltd. Davis, Calif. was used at the rate of 1000 and 2000 per ha to disrupt mating. Using controlled releases of adult moths in replicated plots it was demonstrated that these treatments gave from 80 to 95% control when compared with replicated untreated plots. Total fruit censuses showed the effect of moths immigrating from adjacent orchard with high moth population. Protocols have been tested for commercial application which commenced in 1991.

Blacklight traps were demonstrated effective for collecting female moths which were examined to measure the degree of mating disruption. Rates of about 2.5 mg/ha/h did not result in any decreased mating, however about 5.0 mg/ha/h gave 40-50% decreased mating. Initial emission rates were about 25 mg/ha/h. Now that the technique is proven effective, it remains to be fine tuned and to determine how its long term use effects secondary pests.

NEW LONG-LIFE PASTE FORMULATION FOR USE IN MONITORING AND MATING DISRUPTION DISPENSERS. D.W. Hartley (International Pheromone Systems Limited, Units 12 & 13 Meadow Lane, Meadow Lane Industrial Estate, Ellesmere Port, South Wirral, L65 4EH, U.K.)

A new long-life pheromone paste formulation was used in a modified unitrap for monitoring the maize stalk borer (Busseola fusca).

Trap modification and pheromone effectiveness remained satisfactory over the 5 month trapping season. The same formulation also offered protection and stability to different pheromone chemicals when used in mating disruption trials in cotton for the pink bollworm (Pectinophora gossypiella) and the spiny bollworm (Earias insulana). Laboratory and field test results are discussed.

TWELVE YEARS OF MONITORING CUTWORM POPULATIONS WITH SEX PHEROMONES. J. R. (Bob) Byers (Agriculture Canada Research Station, Lethbridge, Alberta T1J 4B1 Canada)

A pilot study using sex attractant moth traps to monitor population levels and abundance patterns of 8 species of cutworms at 81 sites within a 13,000 km^2 area of southern Alberta was conducted for five years. Estimates of variability of trap catch associated with individual traps, between the duplicate traps at each site, and among sites were obtained for each species. The within-site variability was always much less than the among-site variability, indicating that a meaningful measure of the relative population level at each site was being obtained. Relatively small changes in overall abundance between years could be detected for each species. Subsets of as few as five sites showed year-to-year fluctuations in mean trap catch that were similar in pattern to those of all sites, indicating that year-to-year changes in overall abundance could be detected by monitoring at a relatively small number of sites. The results indicate that surveillance monitoring of pest species of cutworms to detect incipient outbreaks is feasible in terms of both reliability and resource requirements. Based on these findings a long-term surveillance monitoring system has been established.

ROLE OF SEX PHEROMONE IN THE MANAGEMENT OF *HELICOVERPA* (= *HELIOTHIS*) *ARMIGERA* IN INDIA. C.P. SRIVASTAVA (Institute of Agricultural Sciences, B.H.U., Varanasi 221 005, India), M.P. PIMBERT (International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324, A.P., India).

A pheromone trap network was used to monitor the population of *Helicoverpa* (= *Heliothis*) *armigera* (Lepidoptera: Noctuidae) at 23 locations in different agroclimatic zones of India from June 1981 to May 1988. The pattern of pheromone trap catches of *H. armigera* was found to be similar within any agroclimatic zone. The pheromone trap catches appeared to be influenced by the latitude of the location. At northern locations, the peaks in trap catches were more sharply defined and the catches were higher in general as compared to southern locations. At eastern locations the trap catches were lower than elsewhere. At one of the southern locations, Patancheru, the correlations between pheromone trap catches and larval populations for 1981-1988 were +0.82 for the same week and +0.76 when catches of $week_{n-1}$ were related with larval counts for $week_{n=0}$. At one of the northern location, Udaipur, the pheromone trap catches were invariably followed by the peaks in egg and larval counts of *H. armigera*. Thus, the pheromone traps can provide an effective warning system to farmers. Crop maturities and sowing dates of the crops may be manipulated to ensure that the pest sensitive stage of the crop does not coincide with peaks in *Helicoverpa* activity.

RESEARCH INTO MATING DISRUPTION OF THE CURRANT CLEARWING, *SYNANTHEDON TIPULIFORMIS* (CLERCK) (LEPIDOPTERA: SESIIDAE) IN NEW ZEALAND. W.P. Thomas DSIR Plant Protection, Private Bag, Christchurch, New Zealand.

Research and development of the technique of mating disruption of the currant clearwing, *Synanthedon tipuliformis* (Clerck) in New Zealand is reviewed. The synthesised binary pheromone blend (*E, Z*)-2,13octadecadien-1-ol acetate and (*E, Z*)-3,13octadecadien-1-ol acetate used for monitoring this pest has been developed with cooperation from the Shin Etsu Chemical Company of Japan for application in commercial blackcurrant plantations. Field placement of the Shin Etsu polyethylene capillary dispensers containing the pheromone successfully disrupted mating of virgin females tethered in plantations. Male moth orientation to synthetic pheromone lures was completely disrupted at dispenser rates of 250 to 1000 per hectare.

As a consequence of using mating disruption for currant clearwing control, larval infestations in field plantations have significantly declined. The practical development and adoption of mating disruption for control of currant clearwing has been rapid in New Zealand. The technology is now applied by most growers.

Research into mating disruption of other pest Lepidoptera is also being carried out in New Zealand.

TRICHOPLUSIA NI FOR QC BIOASSAY - QC OF THE TEST STRAIN, METHOD DEVELOPMENTS AND LABORATORY SAFETY. Ole Skovmand (Msc PhD, Entomologist, Novo Nordisk A/S, Plant Protection Division / Product Development, DK-2880 Bagsvaerd, Denmark)

A small number of insect species are used for the quality control of microbial products based on Bacillus thuringiensis strains. By tradition, the cabbage looper, Trichoplusia ni, is one of the species used for the control of the lepidopteran active Bt strains used on the market in the Western world: Bt var kurstaki and Bt var aizawai. Standard protocols are elaborated by WHO and USDA for the test procedures but not for the insect rearing. To obtain reproducible results in these tests, the rearing culture must also follow strict protocols regarding diet, temperature regimes, egg-hatching procedures and important abilities of the insects must be surveyed and eventually selected for.

T. ni larvae grow fast and are only at the right stage for the test for a few hours. To provide a sufficient large number of larvae at the right age and size to be used for the test, parameters determining this period must be found and controlled. These parameters are: humidity and temperature around the hatching eggs, the time the neonate are left without food, temperature around the growing larvae and the diet quality.

The temperature regimes selected for the hatching of the eggs and the growth of the larvae before testing are based on day-degree development measurements (Singh and Clare, 1991). Reared on the diet we use a temperature of 29.2 °C which results in most larvae being between second and third instar after 98 hours.

Quality control of the diet is obtained by controlling the ingredients, the production and the final product. The diet is autoclaved immediatedly after production and a sample is drawn from the batch. The sample is evaluated in a bioassay and the batch is only used provided larval development is normal.

Important parameters of the rearing strain is measured and stored in a database used to obtain a comprehensive graphic view of important parameters as generation time, egg-production per day, and LC-50 of the bioassays of a reference product, the standard.

Laboratory safety is not a general problem in insect handling, but handling adult lepidopterans implies a risk of developing allergy to the scale of their wings. Use of a dust mask is only accepted in Novo Nordisk A/S as a temporary solution and a cabinet system with air filters has been developed. These cabinets are used for the egg-production only.

OVIPOSITION BEHAVIOR OF OPIINE BRACONID FRUIT FLY PARASITOIDS: IMPLICATIONS FOR MASS-REARING AND AUGMENTATIVE RELEASE. Russell H. Messing, University of Hawaii, Dept. of Entomology, 7370 Kuamoo Rd., Kapaa, Hawaii, USA 97646

Six species of opiine braconid parasitoids are currently being mass-reared in Hawaii for efficacy testing in augmentative release programs to control tephritid fruit flies. The sequence of behaviours leading to successful oviposition in fly eggs or larvae by adult female wasps (e.g., host-habitat finding, host finding, and host acceptance) is shown to be modified to a substantial degree during the mass-rearing process under insectary conditions. The hierarchy of visual, tactile, and olfactory stimuli used by parasitoids during this host selection process is beginning to be elucidated using a combination of laboratory and field experiments. Use of this knowledge in the mass-rearing program and the implications for subsequent field behaviour and successful biological control are discussed.

Behavioral considerations in culturing *Eldana saccharina* (Lep: Pyralidae) and potential parasitoids

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For the past 10 years, biological control methods have been intensively tested against the stalk borer *Eldana saccharina* Walker, which has plagued the sugar industry since 1970. This has necessitated a large insect rearing operation for both host and parasitoids. Behavioral and kairomonal cues have been considered in developing an artificial diet which would be a good, long-lasting substitute for sugarcane, without masking such cues. This has allowed a reliable supply of host insects, similar in all respects to their feral equivalent. On them have been reared an indigenous larval parasitoid, *Goniozus natalensis* Gordh (Bethylidae), and an exotic pupal parasitoid, *Xanthopimpla stemmator* (Thunb.) (Ichneumonidae). Aspects of the host's and parasitoids' natural behaviour have been used to enhance the process.

UNDERSTANDING INSECT BEHAVIOUR AND BIOLOGY-SHORTCUTS TO EFFICIENT MASS REARING MAIZE INSECT PESTS. John A. Mihm (Entomologist, CIMMYT, Lisboa 27 Apdo. Postal 6-641, Col. Juarez, 06600 Mexico, D.F., Mexico)

Efficient and dependable mass production of insects in various life stages for use in research or pest management requires that rearing techniques and colony management procedures be accomplished with ease and a minimum of labour.

A thorough understanding of insect biology and behaviour, and their limits has been essential in developing colony establishment and management procedures and equipment that have allowed rearing of insects to be accomplished on a truly mass scale in an efficient manner.

Understanding larval/nymphal behaviour is the first step in developing meridic diets, rearing containers and efficient handling procedures to allow mass production of mature larvae and pupae. Cannibalistic of gregariousness larval tendencies have dictated rearing procedures for several maize insect pest species.

Adult behaviour dictated cage design, handling procedures and oviposition substractes that may be used for efficient egg or egg mass production. Several designs of cages and substrates have been developed for efficient egg production of maize stem borers, each having advantages and disadvantages.

Ways in which biological and behavioral attributes can be used to greatest advantage in mass rearing are presented and disscussed.

ADULT COLONY AND EGG HARVEST MANAGEMENT WITHIN THE MASS-REARING OF GENETIC SEXING STRAINS OF THE MEDITERRANEAN FRUIT FLY. Jorge Hendrichs, Gerald Franz (IAEA Laboratories, Entomology Unit, A-2444, Seibersdorf, Austria.)

The Mediterranean fruit fly, Ceratitis capitata (Diptera: Tephritidae) is a major pest of many economically important fruit crops. The Sterile Insect Technique (SIT) is currently used against this pest on an operational scale, either for eradication or for the creation of quarantine barriers or fly-free zones. The use of SIT for suppression of medflies in lieu of insecticide-bait sprays requires the construction of strains that allow for large scale separation of males and females to prevent fruit damage caused by sterile female oviposition punctures. During the last years several sexing strains have been developed. They are based on Y-autosome translocations and use either pupal color mutants, amenable for mechanical sex-sorting, or a temperature sensitive lethal (tsl) mutation as sexing genes. Here we present the required adaptations and modifications of conventional rearing procedures required to accomodate the special needs of new genetic sexing strains subjected to mass production. Emphasis is given to adult colony and egg harvest management and its impact on fly quality and behavior.

RECENT ADVANCES MADE IN REARING COLORADO POTATO BEETLE FOR LABORATORY AND FIELD BIO-ASSAY OF INSECT RESISTANT TRANSGENIC PLANTS. Jay C. Pershing (Monsanto Agriculture Co., 700 Chesterfield Parkway North, Chesterfield, MO 63198, USA)

Insect Behaviour: Its Influence on Development of Technological Research and Pest Management

Manipulating insect behaviour in the development of rearing methods

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Insect rearing is a complex field encompassing science, art and business management practices. Successful rearing depends on sound knowledge of biology, behaviour, habitat, mating behaviour, sex ratio, environmental requirements, and food and feeding preferences of the insect. One of the most important of the basic components necessary to develop rearing methods is to study insect behaviour and manipulate it to our advantage.

Our work during the past 20 years will illustrate how behavioral traits like diapause, cannibalism, oviposition, etc. can be manipulated in the development of more efficient and novel rearing methods. Some examples from literature will also be included.

Further understanding of insect behaviour will lead to:

Proper selection of rearing containers.
Refinement of artificial rearing methods.
Reduction in contamination and disease.
Development of special strains.
Development of quality control and fitness procedures.

ASPECTS OF OVIPOSITIONAL BEHAVIOUR USEFUL IN DEVELOPING QUALITY CONTROL PARAMETERS. J. P. Ochieng'-Odero (ICIPE Research Centre, P. O. Box 30772, Nairobi, Kenya)

Oviposition is crucial in the reproductive success and propagation of various species of insects. In Lepidoptera, certain aspects of ovipositional behaviour can be standardized to produce species specific parameters useful in the assessment of overall quality control. This paper reviews some of these which include: Preovipositional behaviour (attractancy), quality of pheromone produced or released, durations of copulation, success in insemination, nos. of multiple matings, preovipositional period etc). Ovipositional behaviour (egg or cluster size, egg or cluster patterns, duration of oviposition, frequency of ovipostition, total nos. of eggs laid, nos. of fertilized eggs laid etc); and post-ovipositional behaviour (duration of post oviposition life etc).

A BRIEF INTRODUCTION ON ASIAN CORN BORER ARTIFICIAL MASS REARING AND ITS IMPACT ON IPM RESEARCH IN CHINA. Da-rong Zhou, Yan-ying Song, Rui-yun Wei(Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094,China)

The semi-artificial diet formula and relevant rearing technique for the Asian corn borer(ACB) Ostrinia furnacalis (Guenée) developed by the senior author in 1979 and published in 1980, was the first successful practical artificial rearing technique for phytophagous insect pest in China. In this paper, the diet formula and process of preparation; a special designed rearing container and simple pupation device; the quality control of ACB produced and the impacts of the technique on ACB IPM research either directly under the authors' lab or under other institutions were summarized. The former part includes the identification of dominant corn borer species in China, studies on corn varietal resistance to the ACB; determination of distance of dispersal of ACB adults and investigation on population dynamics of Trichogramma spp. in different crop fields under natural conditions and so forth. The latter part includes experiments on sterile male techniques; rearing of ACB parasites; and studies on resistance of ACB to insecticides etc., undertaken by other institutions. All the research works mentioned were impossible to be conducted provided that large amount of uniform and healthy testing insects were not available with such technique.

ASPECTS OF ARTIFICIAL REARING OF INSECTS IN TAIWAN. Chau-chin Hung, Jenn-sheng Hwang (Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Wufeng, Taichung, Taiwan 41301, China)

Artificial mass-rearing insects had already been started about 1947 in Taiwan except artificial rearing of beneficial insects. The most famous case was the mass production of *Trichogramma australicum* for biological control of sugarcane borers. Since 1975, in order to execute the mass-rearing programs of steriled fruit flies and *Trichogramma chilonis* for controlling the Oriental fruit fly and Asian corn borer, the artificial diets and mass-rearing techniques of the Oriental fruit fly and *Corcyra cephalonica* were deeply investigated and well established. National Science Council and Council of Agriculture have conducted the big project "Insect Sex Pheromone" since 1983, the artificial mass-rearing methods of targeted insects, such as *C. medinalis, Adoxophyes* sp., *H. armigera, S. litura, S. exigua, O. furnacalis, P. citri, P. minor, E. notanthes, C. formicarius, P. xylostella*, etc., have been studied and some results are asset in mass production of insects for experimental use. There were 27 references about insect-rearing during 1945-1975, the reports emphasized on mass-rearing of natural enemy. From 1976 to 1991, the reports sum up to 64 papers, most of them focus on rearing research of insect pests. The importance and value of the method of artificial mass-fearing insects is gradually recognized. About 45 species insects can be mass reared with artificial diets or natural foods, including Lepidoptera, Coleoptera, Homoptera, Diptera, Thysanoptera, Hymenoptera, and mites in Taiwan.

POPULATION VARIATION OF PHEROMONE PRODUCTION IN MOTHS. Jia-Wei Du (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China).

Biologists have known for a long time that individual variation is a pervasive phenomenon of natural populations, presumably controlled by genetics. Recent studies on the individual variation of insect sex pheromone systems utilizing E/Z isomeric blends, such as in *Ostrinia furnacalis* and *Rondotia menciana*, show that this ratio is controlled within narrow limits (C. V. <10%). Some species, however, do not produce the E-isomer, but rather use a pheromone blend composed of positional isomers (e. g. Z9/Z11). In one of these, *Scirpophaga incertulas*, the individual variation also is controlled within a narrow limit, but in others, *Heliothis armigera* and *Dendrolimus punctatus*, it has a high % C.V. This could mean that it is a product of additional 'extra' variation due to environmental factors and interpopulational differences. Studies on the individual variation of sex pheromone blends and its relationship to species specificity have significance in understanding interspecific competition and the structuring of insect communities.

PHEROMONE DIFFERENCES WITHIN A COMPLEX OF TORTRICID MOTHS. S.P. Foster, DSIR Plant Protection, Private Bag, Palmerston North, New Zealand.

A complex of tortricid moth pests of fruit crops in New Zealand have provided a good model for comparative pheromone studies on closely related species. Studies on the sex pheromones of two endemic species, *Planotortrix excessana* (sensu Dugdale 1966) and *Ctenopseustis obliquana* (sensu Green and Dugdale, 1982) led to the discovery that these described species actually consisted of two and three sibling species, respectively, each using distinct sex pheromones. As well as the differences between the sibling species, the pheromone systems of the individual sibling species show a considerable amount of intra-specific variation in both production of the pheromone by the females and responses to ratios of the pheromone components by the males. For the biosynthesis of their respective sex pheromones, the New Zealand species use routes that are distinct from that used by another member of the complex, the indigenous Australian species, *Epiphyas postvittana*, as well as from most other tortricid species. Studies on the endocrinology of, and the effects of mating on, pheromone production also show differences between the species. Males of these species show differences in their flight responses to their respective pheromones, particularly with regard to plume structure. Further comparative studies on these species should allow greater insights into the important physiological and behavioral mechanisms underlying pheromone systems of Lepidoptera.

Moth pheromone biosynthesis: Regulation of female pheromone production in the European corn borer, *Ostrinia nubilalis* (Pyralidae: Lepidoptera). Junwei Zhu, Christer Löfstedt, Bengt Olle Bengtsson and Marie BengtssonDepartment of Ecology, Lund University, S-223 62 Lund, Sweden

Many moth species use different ratios of E- and Z11-14:OAc as a sex pheromone. The major difference in pheromone production between the so-called E and Z strains of the European corn borer *Ostrinia nubilalis* is controlled by two alleles at a single autosomal locus. E strain females produce an (*E*)-11-tetradecenyl acetate pheromone with 1-3 % of the Z isomer, whereas Z strain females produce the opposite blend. This difference is probably controlled by the geometric selectivity of a reductase. Heterozygotes have both the E and the Z form and produce the intermediary blends characteristic of F_1 hybrids. However, the existence of modifier genes, which affect the precise ratio of *(E)*-11- and *(Z)*-11-tetradecenyl acetate in heterozygotes, has been confirmed by back crossing F_1 males to females from the E and Z parental strains. Different ratios of deuterium-labelled precursors (14:acyl and E/Z-11-14:acyl) and possible intermediate precursors(E/Z-11-tetradecenal and E/Z-11-tetradecenol) were topically applied in different ratios to individual female pheromone glands of the two strains (Z, E) and hybrid *Ostrinia nubilalis*. Both acid and aldehyde precursors were selectively reduced, whereas the acetylation was non-specific. A biosynthetic model explaining the differential pheromone production among E-strain, Z-strain, and hybrids is presented. *In vitro* experiments studying the specificity of the delta-11 desaturase and reductase systems are underway to test the proposed model.

ENDOCRINE CONTROL OF PHEROMONE PRODUCTION IN MOTHS. Wendell Roelofs, Russell Jurenka (Department of Entomology, Cornell University, Geneva, NY 14456) and Gemma Fabrias (Dept. Quimica Organica Biologica, CID-CSIC, Barcelona, Spain).

The production and release of pheromone components in many moth species is synchronized with the corresponding male's window of response. The type of endocrine control involved in regulation of this pheromone production differs among species. A brain neuropeptide, labelled PBAN (pheromone biosynthesis activating neuropeptide) by its discoverer Dr. A. Raina, was found to regulate pheromone production in *Heliothis* species (Noctuidae). In the redbanded leafroller moth, *Argyrotaenia velutinana* (Tortricidae), two peptides were identified as necessary for pheromone production - a brain neuropeptide similar to PBAN and a peptide released from the bursa copulatrix upon stimulation by PBAN. The site of biosynthesis, the mode of action, and the receptors for these two pheromonotropic hormones is now under investigation.

A MOTH FOR ALL PURPOSES; SEX PHEROMONE COMMUNICATION IN THE TURNIP MOTH, *AGROTIS SEGETUM*. Christer Löfstedt (Department of Ecology, Lund University, S-223 62 Lund, Sweden).

Specificity in sex pheromone communication will be discussed using the turnip moth, *Agrotis segetum*, as an example. The pheromone of *A. segetum* has been studied extensively by several research groups. The pheromone has been identified as a mixture of the homologous acetates Z5-10:OAc, Z7-12:OAc and Z9-14:OAc, which are all biosynthesized from palmitic acid by Δ11-desaturation and subsequent chain shortening, reduction and acetylation. The males have specialized receptors for each of the pheromone components, and the different types of receptors innervate different regions of the macroglomerular complex in the antennal lobe. The specificity of the Z5-10:OAc receptor has been characterized using more than 60 pheromone analogues and pheromone binding proteins selective for Z5-10:OAc and Z7-12:OAc, respectively, have been characterized from moth antennae. In addition to the three homologous acetates more than 15 chemically similar structures were identified from gland extracts. Some of these may substitute for the major pheromone components when one of these is missing, which may be an adaptation to high population variation in female pheromone production. Turnip moth populations from many places in Eurasia and northern Africa respond maximally to the three component mixture, whereas African populations from south of Sahara are attracted to Z5-10:OAc alone. Mechanisms of and adaptive explanations for differential production and response are currently under investigation.

OLFACTORY PROCESSING OF PHEROMONE BLEND QUALITY IN MOTHS. Thomas C. Baker (University of California, Riverside, CA, USA).

The activity of antennal receptor cells sensitive to different pheromone components is integrated in the CNS, and results in pheromone-mediated upwind flight and casting flight. The output of the antennal neurons is affected by temperature, the concentration of the pheromone filaments in the plume, and the arrival rate of the filaments. All of these factors determine whether or not the receptor cells can become disadapted fast enough in order to respond to the next incoming filament. The selective adaptation of neurons responsive to the most abundant component in the blend can cause upwind flight behavior to cease, or else for the optimal blend ratio preferred by males to shift towards one in which the major component is emitted at a higher proportion than in the natural blend. Blend quality is integrated by cells in the CNS whose phasic on and off output is sharpened by a combination of inhibition and excitation. Blend quality is also integrated in tonic-firing cells in the CNS, whose long-lasting excitation persists for tens of seconds after the odor is switched off. Both of these temporally different types of firing patterns of pheromone-blend integrating cells correspond to the behaviors necessary for successful pheromone source location: upwind flight and casting flight, respectively. Antennal receptor neurons that are specifically tuned to each of the different pheromone components of a species' blend have been shown to send axons to specific sub-compartments of the macroglomerular complex of the antennal lobe of the brain. It is not clear how these sub-compartments are connected in order to produce both the phasic and the tonic output necessary for upwind flight and casting behavior.

OLFACTORY SIGNAL TRANSDUCTION IN MOTH ANTENNAE. Heinz Breer (University Stuttgart-Hohenheim, **D-7000 Stuttgart 70, Germany**)

Pheromone binding proteins which are supposed to mediate the transfer of pheromones through the sensillum lymph in order to reach the olfactory receptor cells have been cloned and sequenced. They represent globular proteins with distinct hydrophilic and hydrophobic domains. Several homologous proteins encoded by a multigene family have been identified. the microdiversity of binding proteins suggests that each protein may be tuned to a particular pheromone.

The mechanisms mediating the chemo-electrical transduction in receptor cells are still elusive, although several lines of evidence suggest an involvement of signal-amplifying reaction cascades. Using a rapid kinetic methodology, the formation of second messenger induced by pheromones and odorants in antennal preparations was monitored in the subsecond time range. A number of features of this rapid and transient molecular signal favour the concept that receptor-activated, G-protein-mediated reaction cascades are involved in the chemo-electrical transduction process. Molecular elements of the transduction cascade are presently identified using cloning techniques.

ECOLOGICAL ASPECTS OF PHEROMONE-MEDIATED MATING IN MOTHS. Jeremy N. McNeil (University Laval, Ste. Foy, P.Q., Canada, G1K 7P4), Johanne Delisle (Frets Canada, Centre de Foresterie des Laurentides, 1055 rue du PEPS, Ste. Foy, P.Q. Canada, G1V 4C7).

Despite the specificity and non-toxic nature of semiochemicals, and their successful deployment against an array of agricultural and forest insect pests worldwide, the use of these behaviour-modifying chemicals in integrated pest management programs has not always lived up to initial expectations. The apparent failures have resulted, at least in part, from a limited understanding of the ecological aspects of the semiochemically mediated systems that we wish to manage. In this presentation we will examine how (i) abiotic (temperature, photoperiod, relative humidity, light intensity) and biotic (host plants, adult age and previous mating history) may affect pheromone-mediated mating in different moth species, and (ii) an understanding of the behavioural ecology, including aspects related to mate choice and male-male competition, of such mating systems could provide insight resulting in the more efficient use of semiochemicals in the management of pest species.

FINDING A POINT SOURCE OF PHEROMONE IN A TURBULENT WORLD. Ring T. Cardé, M. A. Willis (Department of Entomology, University of Massachusetts, Amherst, MA, USA) and J. Murlis (Ministry of the Environment, U.K.).

In male moths the location of a female in the field by following her pheromone plume over distances of tens of meters poses a navigational challenge. Because the long axis of a pheromone plume is only infrequently aligned with the upwind direction and the upwind direction is only sporadically aimed toward the plume's source, pheromone-mediated upwind anemotaxis alone will not routinely direct a male to the female's location. Loss of the plume is frequent and the strategy of casting may aid its relocation. Flight of the male gypsy moth, *Lymantria dispar*, was video recorded in the field at distances of 2, 5, 10 and 20 m from the source of pheromone. Observed differences in flight characteristics at these three distances may be caused by several features of the plume's temporal and spatial structure and not simply the concentration of pheromone. Principal component analysis of flight tracks at these three distances showed that 90% of the variability in the data is explained by four factors: velocity, steering, steering feedback (optomotor information), and oscillator.

FLIGHT ACTIVITY OF THE LIGHT BROWN APPLE MOTH, *EPIPHYAS POSTVITTANA* (WALKER) (TORTRICIDAE), IN RELATION TO REPRODUCTIVE BEHAVIOUR. W. Danthanarayana (Department of Zoology, The University of New England, N.S.W. 2351, Australia).

Tethered flight assays and actograph techniques show that flights began on the day of emergence, peaked at the ages of four and five days in females and five days in males, and lasted for nine to ten days. Development of flight capacity was well synchronised with a buildup and decline of reproductive behaviours (calling, mating and oviposition). Flights are thus inter-reproductive, without a distinct pre-oviposition period. Results confirm field studies with suction traps that there are two flight peaks, a major peak after sunset and a minor peak after sunrise. During the post-sunset flight period males were observed to respond to calling behaviour of females and to mate, and females to oviposit. The morning flights extended for several hours, during which feeding was the main preoccupation in both sexes. The sexual behaviour and flight activity of *E. postvittana* are discussed in relation to those of other tortricids and Lepidoptera in general.

THE ROLE OF CHEMISTRY IN THE CONTROL OF INSECT BEHAVIOUR. John A. Pickett (Department of Insecticides & Fungicides, AFRC, IACR, Rothamsted Experimental Station, Harpenden, Herts. AL5 2JQ, U.K.)

Modern analytical and synthesis techniques are essential for identifying semiochemicals (behaviour - controlling chemicals) involved in the many facets of insect chemical ecology, but use of these techniques must be completely integrated with biological studies. For economy in behavioural investigations and of biological material, direct coupling of analytical systems, e.g. high resolution capillary gas chromatography, with electrophysiological preparations from the insect sensory nervous system, e.g. recordings from single antennal cells, is advantageous. For the investigation of sensory receptors and biosynthetic pathways, synthesis chemistry can yield labelled substrates, affinity reagents and inhibitors. Synthesis chemistry also provides cues for in-depth behavioural studies and can make available analogues, inhibitors and prosemiochemicals for field monitoring and direct pest management programmes. However, it is the preparation of nature-identical semiochemical samples for deployment in stimulo-deterrent diversionary (push-pull) strategies that is currently offering most promise for exploiting insect chemical ecology in pest management. These various aspects of semiochemistry will be discussed in relation to new developments in studies on the chemical ecology of some Diptera, Coleoptera and Hymenoptera, and their hymenopterous parasitoids.

Chemical Communication of the American Palm Weevil, *Rhynchophorus palmarum* A. C. Oehlschlager,[1] H. D. Pierce, Jr.,[1] B. Morgan, J. Cabezas,[1] P. D. C. Wimalaratne,[1] K. N. Slessor,[1] G. G. S. King,[1] G. Gries,[2] R. Gries,[2] J. H. Borden,[2] L. F. Jiron,[3] C. M. Chinchilla[4] and R. Mexon[4]. [1]Department of Chemistry, Simon Fraser University, Burnaby, B. C., Canada, V5A 1S6, [2] Department of Biological Sciences, Simon Fraser University, Burnaby, B. C., Canada, V5A 1S6, [3]Faculty of Agronomy, University of Costa Rica, San Jose, Costa Rica, [4]Palm Research Program, Palma Tica, Coto, Costa Rica. 1991.

Oil palm and coconut palm plantations cover an estimated 400,000 Ha in Central and South America and constitute an annual crop valued in excess of $550,000,000 US. The most devastating pest of this crop is the American palm weevil, *Rhynchophorus palmarum*, which causes an estimated $50,000,000 US annual loss through severe direct damage and inoculation of palms with lethal red ring nematode. No control strategy for this insect beyond removal of infected trees has emerged to date. Two male-produced pheromones have been identified for the palm weevil. The identification and field activity of the pheromones and several host volatiles as well as development of a trapping strategy to control this insect will be discussed.

MATING BEHAVIOUR AND SEX PHEROMONE OF PERILLA LEAF PYRALID MOTH, *PYRAUSTA PANOPEALIS* WALKER (LEPIDOPTERA: PYRALIDAE). Kwang Youl Seol (Sericultural Experiment Station, RDA, Suwon, Korea), Seok Ku Kang (Department of Chemistry, Sung Kyun Kwan University , Suwon, Korea)

To establish the successive rearing method of the perilla leaf pyralid, *Pyrausta panopealis* Walker, experiments were carried out with three diets based on a JAMSI-type artificial diet for silkworm. On the SS4 diet containing 40% of perilla leaf powder the pupal and adult yields were higher than those on the fresh green perilla leaves.

The calling and mating behaviour of the pest insect were observed. The emergence of most males and females took place during light period, showing a different emergence pattern from the pattern of nocturnal insect and the receptive female exhibited a stereotyped calling posture by extruding and bending the abdominal tip towards the dorsal surface.

The males did not show any stereotyped mating dance when the females began calling. The attraction of males to the females was therefore used as a criterion for the sex pheromone bioassay. In the laboratory bioassay, the males strongly responded and were attracted to virgin females or the abdominal tip extract of virgin females.

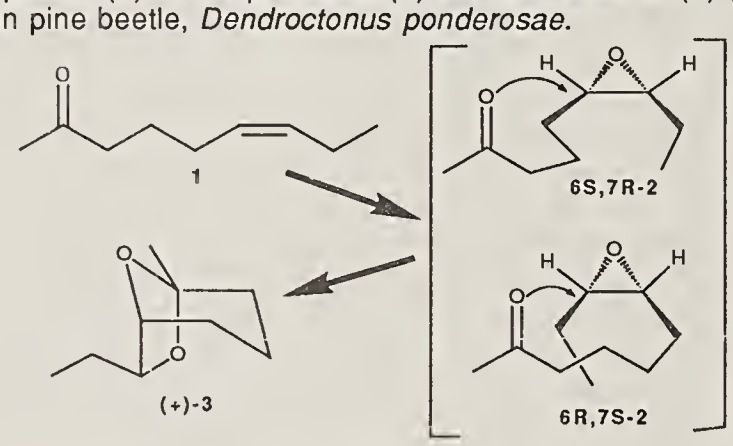
Now the entire components of the sex pheromone are under identification.

OVIPOSITION ATTRACTANTS FOR *CULEX* MOSQUITOES. Jocelyn G. Millar, Jeffrey W. Beehler, John D. Chaney, and Mir S. Mulla (Dept. of Entomology, University of California, Riverside, CA 92521, U.S.A.)

Mosquitoes use a variety of chemical and physical cues to locate suitable breeding sites. Compounds which attract and stimulate oviposition by gravid *Culex* mosquitoes have been isolated and identified from fermented Bermuda grass infusions. Several bioassays have been used to determine whether chemical cues are detected by olfactory or contract chemoreceptors, and to ascertain the roles of specific chemicals in the behavioral sequence culminating in oviposition. The interaction of chemical cues from oviposition sites with the known egg-raft pheromone was also studied. In addition to chemical cues, color and contrast of the oviposition water were shown to be important, and there was strong interaction between chemical and visual cues from the oviposition water.

Mechanism of Brevicomin Biosynthesis in a Bark Beetle. A. C. Oehlschlager and D. Vanderwel, Department of Chemistry, Simon Fraser University, Burnaby, B. C. CANADA, V5A 1S6 and Department of Chemistry, University of Winnipeg, Winnipeg, Manitoba, R3B 2E9, CANADA

Labelling studies have shown that (Z)-6-nonen-2-one (**1**) is the precursor of (+)-*exo*-brevicomin (**3**) in bark beetles. Labelling studies with [^{18}O]-oxygen gas and [^{18}O]-water indicated that the conversion of this precursor to (+)-(**3**) proceeded *via* a keto epoxide (**2**). Remarkably double labelling studies indicated that both enantiomers of the epoxide (**2**) of the precursor (**1**) are converted to (+)-(**3**) in the mountain pine beetle, *Dendroctonus ponderosae*.



IDENTIFICATION OF POLYENIC COMPOUNDS FROM FEMALE OR MALE MOTHS

W. Francke, F. Schmidt (Inst. of Organic Chemistry, D-W 2000 Hamburg 13, Germany)
M. Toth, G. Szöcs (Plant Protect. Inst. Hung. Acad. Science, H-1525 Budapest, Hungary)
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Polyunsaturated fatty acids are regarded as precursors of a set of uneven numbered hydrocarbons and oxygenated derivatives which we identified from female or male moths.
Pheromone systems of female Geometrid moths were found to be made up by homoconjugated polyenic hydrocarbons like (Z,Z,Z)-3,6,9-heptadecatriene or its bishomologue, (Z,Z,Z)-3,6,9-nonadecatriene, and positional isomers of corresponding chiral monoepoxides. Each species shows a specific blend of at least two compounds of the same chain length including defined enantiomeric proportions. Synthetic mixtures proved to be highly attractive in the field.
The androconial organs of Arctiid moths, *Amerila* (*Rhodogastria*) spp., contain complex blends of various classes of compounds among which undecapolyenes and highly unsaturated wax type esters are particularly interesting. (E,Z,Z)-1,3,5,8-Undecatetraene and (E,Z,Z)-1,3,5,8,10-undecapentaene show striking structural relations to some polyenes known from the essential oil of plants and to pheromones of brown algae. (Z,Z,Z)-3,6,9-Dodecatrienyl (Z,Z,Z)-3,6,9-dodecatrienoate or (Z,Z,Z)-9,12,15-octadecatrienyl (Z,Z,Z)-3,6,9-dodecatrienoate are among the most highly unsaturated compounds known from insects. Are there biogenetic relations between these esters and the polyenes?
Do unsaturated wax esters or more simple ones like (Z)-9-tetradecenyl (Z)-9-tetradecenoate represent a general chemical principle as storage forms of Lepidopteran sex pheromones like (Z)-9-tetradecenylacetate?

NOVEL SEX PHEROMONE COMPONENTS OF LEPIDOPTEROUS COTTON PESTS FROM SOUTH AMERICA. Alan Cork, D.R. Hall, D.G. Campion, D.J. Chamberlain (Natural Resources Institute, Chatham Maritime, Kent ME4 4TB, U.K.) & A. Almestar S. (FUNDEAL, Puira, Peru).

NRI and FUNDEAL have collaborated to investigate the use of pheromones in integrated management of the major insect pests of cotton in Peru. Sex pheromone traps have been used to monitor pink bollworm, and sex pheromones have now been identified for the cotton leafworms, *Alabama argillaceae* and *Anomis texana* (Lepidoptera: Noctuidae) and the cotton leafminer, *Bucculatrix thurberiella* (Lepidoptera: Lyonetidae).

The major components of the pheromones of *A. argillaceae* and *A. texana* are homologous, chiral monomethyl-substituted hydrocarbons. The enantiomers of these were synthesised from a common homochiral precursor, (*S*)-methyl 3-hydroxy-2-methyl propionate. For *A. texana*, the *S* enantiomer was attractive to the male moths while the *R* enantiomer was unattractive but did not affect the attractiveness of the *S* enantiomer in the racemic mixture. For *A. argillaceae,* the *S* enantiomer was attractive but the racemic mixture was unattractive due to the inhibitory effect of the *R* enantiomer.

The sex pheromone of *B. thurberiella* consists of two nitrate esters in approximate ratio 98:2. The major component alone was unattractive, but traps baited with the blend of the two components caught ten times more male moths than traps baited with a virgin female moth in field tests. This is the first time nitrate esters have been found as sex pheromone components of Lepidoptera.

SEXUAL BEHAVIOR AND CHEMICAL SIGNALS IN *Eurycotis floridana* (Dictyoptera, Polyzosteriinae). Ana-Isabel David-Henriet and Jean-Pierre Farine (Laboratoire de Zoologie, CNRS-URA 674, Faculté des Sciences, 6 Bd Gabriel, 21000 DIJON - France).

In *Eurycotis floridana* copulatory success occurs when males are about 10 days old while females are sexually mature at 20 days.

During the sexual behavior, the male adopts a calling posture which exposes its 2nd and 8th tergites. In response to the male sex pheromone, the female opens its genital atrium, this behavior increasing the excitation of the male. Then, the male adopts a parade posture exposing tergites 2, 7 and 8. The female climbs onto the male and licks aphrodisiacs on tergites 1 and 2. Then, both sexes are in a proper position for mating.

Our results demonstrate that females are attracted by 0,1Eq. of male tergite 8 secretions. These secretions, at a higher concentration (0,5 Eq.), also attract the males. Observations suggest that the secretory products from tergite 7 are responsible for the short range attraction of mature females.

GC analysis indicates that (2R, 3R)-butanediol and dodecanol are the major components in tergite 8. The major compounds produced by tergite 7 were identified as (2,5)dimethyl 4-hydroxy-3(2H)furanone (furaneol) and a methyl 4-hydroxy-3(2H)furanone.

STERNAL GLANDS IN ANTS : A MORPHOLOGICAL AND ULTRASTRUCTURAL SURVEY.

J. Billen (Zoological Institute, University of Leuven, Naamsestraat 59, B-3000 Leuven, Belgium)

Social insects are characterized by an overwhelming variety of exocrine glands, the majority of which have a function in the social organization by their production of pheromones. The many glands either correspond to the epithelial type or are composed of bicellular secretory units.

Until now, a total of 37 different known glands can be distinguished in ants. A very striking variety occurs among their sternal glands, where we can find several different types according to their anatomical location and cellular organization. We can find sternal glands that open directly through the sternal tegument, through the soft intersegmental membrane, and into the cloacal chamber.

Opening directly through the sternal tegument are e.g. the Pavan's gland in Dolichoderinae (epithelium) and the glands underneath the 7th sternite in the weaver ant *Oecophylla* (secretory units). Opening through the intersegmental membrane are e.g. several secretory unit glands among the Ponerinae, while glands opening into the cloacal chamber are found in Ecitoninae army ants (epithelium lining the inner wall of the 7th sternite) and in the cloacal gland (secretory unit type) of some *Camponotus* and *Cataglyphis* among the Formicinae.

HOW THE LARVAE OF *FORFICULA AURICULARIA* RECOGNIZE THEIR MOTHER?

Z.B. LIU[1&2], & M. VANCASSEL[1], [1]Laboratoire d'Ethologie, CNRS UA 373, Université de Rennes I, 35042 Rennes cedex, France, [2]Laboratory of Entomology, Institute of Zoology, Shaanxi Normal University, 710062 Xi'an Shaansi, China.

In the sub-social species *Forficula auricularia*, the female generally opens her burrow four days after hatching of the larvae. From that time the young forage outside at night and regularly come back and stay at the maternal burrow for daytime.

The larvae discriminate the maternal burrow on olfactory cues but only when the odour of the female is present. In a choice box the larvae discriminate the odour of their mother (collected by pentane extraction) from the odour of a strange female.

When the mother is replaced by a strange maternal female at the hatching day, the larvae join their adoptive mother rather than their biological mother four days latter. The larvae join the odour of their adoptive mother as well.

PRESTINGING DEFENSIVE BEHAVIOUR IN POLISTINE PAPER WASPS. H.R. Hermann, (Dept. of Entomology, University of Georgia, Athens, GA 30602, USA)

Polistine wasps characteristically express themselves in a multitude of prestinging displays. While many displays are expressed in similar ways by different species, there are usually some interspecific differences. As examples, *Polistes annularis* distinguishes itself by using its forelegs more than most other polistine species, while *Polistes exclamans* is more prone to wing fluttering and wing waving. In certain species, more unusual forms of defensive displays are expressed. For example, *Parachartergus aztecus* covers its bag nest and extends aposematically colored wings. It also is and obligate ant-acacia-nesting species which protects it from army ant attack. *Polybia diguetana*, a darkly colored species, not only covers its bag nest but it demonstrates a wing whishing behavior that is unlike any other behavior described thus far. It may be that each species has a special combination of these defensive displays that can be used to characterize their degree of aggression.

VISUAL COURSE CONTROL IN BEES: NEURAL MECHANISMS. L.J. Goodman, (Dept. of Biological Sciences, Queen Mary Wesfield College, London, England)

Identified, directionally-selective, motion sensitive interneurons descending from the brain of the bee can signal information about roll, pitch and yaw to the motor thorax. Analysis of the directional tuning and spatio-temporal properties of the 22 cells shows that they have subtly different response properties, e.g. there are at least four different types of horizontally-sensitive cells. In addition, ocellar input modifies the response of many of these descending cells. The role of this array of neurons is considered in relation to optomotor and voluntary course control in the bee.

SEMIOCHEMICAL COMMUNICATION OF ANTS.

Ryohei Yamaoka and Toshiharu Akino (Department of Applied Biology, Kyoto Institute of Technology, Kyoto 606 JAPAN)

Semiochemical communication systems in the microcosmos of ants presented. Firstly, as an example of communication between colony members, the trail pheromone communication system of *Lasius fuliginosus* was examined. A highly active orientation pheromone was isolated and found to be secreted along with an antiabsorbent. Secondly, the territory marking pheromone of the ant was isolated and identified as a mixture of cuticular hydrocarbons. The ant cuticular hydrocarbon profile (CHP) was colony dependent, providing the first example of the direct role of CHP in colony communication. The cuticular hydrocarbon resemblsance between the ant colony and its nest-mate symbiont was also examined and similar CHP's were found. Finally, the question of how symbiosis between ants and aphids arose was chemically studied and the most probable origin might be considered a lack of ant fagostimulant on the aphids.

BOUQUETS AND BLENDS: ANALYSIS OF BEHAVIOURAL AND PHYSIOLOGICAL RESPONSES TO EXOCRINE SECRETIONS OF *CAMPONOTUS*.

R M Crewe & P G Hawkes, Dept of Zoology, University of the Witwatersrand, Johannesburg, South Africa

The chemical composition of the secretions of Dufour's gland, poison sac and mandibular glands of workers a number of *Camponotus* species was determined using GC-MS analysis. An equivalent analysis was conducted on male mandibular glands.

The behavioural responses of workers to these exocrine secretions was recorded using a video recorder. In addition, physiological responses of the individuals was measured using a CO_2 analyzer.

The results demonstrate that there are caste differences in response to male exocrine secretions and to worker secretions. In addition, the mechanism of response to blends from a single glandular source and to blends that are produced from combinations of different glandular secretions will be discussed. This data wil be used to evaluate the validity of the Bossert-Wilson model for the generation of active spaces for the signals.

ROLE OF CUTICULAR HYDROCARBONS IN THE FEMALE *FORFICULA AURICULARIA* ATTRACTIVENESS.

Z.B. LIU[1&2], J.L. CLEMENT[3], AND M. VANCASSEL[1], [1]Laboratoire d'Ethologie, CNRS, UA 373, Université de Rennes I, France, [2]Laboratory of Entomology, Institute of Zoology, Shaanxi Normal University, 710062 Xi'an Shaansi, China, [3]Laboratoire de Neurobiologie, CNRS, LNB8 Communication Chimique, BP71, 13042 Marseille Cedex9, France.

In this sub-social earwig (Dermaptera) the family group depends mainly on the attractiveness of the female on her larvae. This attraction was obtained in test situations using maternal females or apolar fraction of their cuticular extracts. These biological tests also showed that female attractiveness was modulated according to the contacts females could previously have with larvae.

Cuticular hydrocarbons were analysed and characterized using gas-chromatography followed by mass spectrometry. More than sixty hydrocarbons were characterized. Principal composant analysis (PCA with instrumental variables) showed that some hydrocarbons were better represented in females known to be the most attractive. These hydrocarbons include 7 and 9 tricosene already described as pheromones in Diptera.

ALARM PHEROMONES: MULTIFUNCTIONAL SIGNALING AGENTS. M.S. Blum (Dept. of Entomology, University of Georgia, Athens, GA 30602, USA)

Eusocial insects have utilized alarm pheromones to subserve a variety of functions which are highly adaptive in the social milieu. Ants, in particular, have been demonstrated to produce a large variety of compounds that are used in both inter- and intraspecific contexts. The diverse alarm pheromones are produced in large quantities relative to other signaling agents produced by eusocial species. In addition to alarm, these chemical releasers possess functions as diverse as antibiotic agents, attractants, defensive allomones, dispersive agents, and trail pheromones. The significance and function of qualitatively "plethoric" signals will be analyzed in terms of the release of alarm behavior in ants and bees. The chemistry and behaviors of multifunctional alarm pheromones will be discussed.

OPEN AND CLOSED SOCIETIES IN SOCIAL INSECTS :THE ROLE OF CUTICULAR CHEMICAL SIGNATURES

J.L. CLEMENT, A.BONAVITA-COUGOURDAN & A.G. BAGNERES
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Ethological and genetic studies provide information on colony individuality and possible colony fusion in social insects. Generally a high degree of aggressivity prevents inter- or intraspecific colony fusions. The epicuticular signatures, recognized by contact, were extracted using organic solvents from Ants (*Camponotus vagus*) and Termites (*Reticulitermes (lucifugus) grassei* and *R. (l.) banyulensis*). These signatures were transferred to lures where it triggers interspecific aggression in termites and intercolonial aggression in ants. It was found to be mainly present in the apolar fraction of the cuticular extracts, which contained only hydrocarbons and determined by GC/MS techniques. In *Camponotus vagus*, variation of relative proportions of dimethylalkanes characterize the chemical signatures in different colonies. In *Reticulitermes* , chemical recognition contributes towards isolation of the two species ; quantitative and qualitative variation of saturated and insaturated hydrocarbons may be responsible of the chemical signal.

QUEEN HONEY BEE SOCIOCHEMICALS. K.N. Slessor & M.L. Winston (Dept. of Chem/Biochem. and BioScience, Simon Fraser Univ., Burnaby, Canada, V5A 1S6)

The mandibular glands of the queen honey bee produce a complex of 5 chemicals which when presented to workers elicits retinue behaviour. However, this blend has an even more profound effect on workers both inside and outside the colony and studies will be presented that document these effects.

Radioactively labelled pheromone has been used to quantitatively follow the fate of the queen's signal throughout the colony and has led to a model of pheromone transmission in the honey bee colony. The implications of the model will be examined and experiments designed to further elucidate the effect of the pheromone will be presented.

VIS-7

Homopteran Feeding Behaviour: Recent Research Advances and Experimental Techniques

AC ELECTRONIC MONITORING SYSTEMS AND THEIR ROLE IN THE STUDY OF APHID, LEAFHOPPER AND OTHER HOMOPTERANS' FEEDING BEHAVIOR. Elaine A. Backus (Department of Entomology, University of Missouri, Columbia, Missouri 65211 U.S.A.)

Electronic monitoring systems (EMS) have revolutionized our knowledge of the feeding behavior of homopterans. The first type of monitor, the AC EMS, was invented by D. L. McLean and M. G. Kinsey of the University of California-Davis, who published its first designs in 1964. Since then, many modifications in design have been developed, and over 100 papers have been published on research using the AC EMS. The first half of this presentation will provide a brief review of the history of the AC EMS, the specific information it can provide about homopteran feeding behavior, and the applications of the instrument in studies of host-plant resistance, vector-pathogen relationships and mechanisms of plant injury. The second half will introduce a new version of the AC EMS which employs a differential amplifier (to cancel environmental noise) combined with precision full-wave rectification (to preserve signal components which older versions discarded). This new monitor produces waveform output with less noise, more stability and finer detail than any other, currently available AC EMS. Applications of this new monitor to modern research needs will be discussed.

THE DC ELECTRICAL PENETRATION GRAPH (EPG) AS A HIGH RESOLUTION TOOL IN THE STUDY OF FEEDING BEHAVIOR BY APHIDS. W.F. Tjallingii (Dept. Entomology, Agricultural University, Binnenhaven 7, 6709 PD Wageningen, The Netherlands).

Plant and insect are interconnected by two electrical conductors: the stylet c nals during plant penetration. DC signals reflect two kinds of electrical phenomena in and near these canals, (1) potentials raised biologically and (2) conductivity changes, whereas AC signals only reflect the latter. Hence DC can provide higher behavioral resolution.

A NEW SYSTEM UTILIZING THE PERSONAL COMPUTER FOR ANALYSIS OF FEEDING BEHAVIOR BY HOMOPTERANS. Susumu Kawabe (National Institute of Entomology & Sericultural Science, Ohwashi 1-2, Ibaraki-305, Tsukuba, Japan)

Technical innovation of the AC electronic measurement system (EMS) of homopteran feeding behavior was achieved by utilization of a personal computer. Analogue data of 24 hours' feeding were converted into digital data, input to a computer and stored in the harddisk. The new system makes more efficient, detailed and reliable analysis of feeding behavior possible.

AN ADAPTATION OF THE PICKOVER SYMMETRIZED DOT PATTERN FOR GRAPHICAL REPRESENTATION OF APHID-GENERATED WAVEFORMS OF AC ELECTRONIC MONITORING. Michael Ellsbury (USDA-ARS Northern Grain Insects Lab, Brookings, South Dakota 57006, USA)

Digital data from waveforms recorded during electronic monitoring of aphid feeding were transformed as a series of paired polar coordinates and graphically presented as symmetrized dot patterns (SDP). Distinctive SDP's associated with aphid salivation, x-waves and phloem ingestion waveforms may have application to computerized pattern recognition during electronic monitoring.

CLOSE-UP VIDEO COMBINED WITH ELECTRONIC MONITORING AND BEHAVIOURAL EFFECTS OF APHID ANTIFEEDANTS Jim Hardie (AFRC Aphid Biology Group, Imperial College at Silwood Park, Ascot, Berks SL5 7PY, U.K.)

Simultaneous electronic and close-up video recordings during initial plant contact showed that stylet insertion was accompanied by the cessation of body and antennal movement. The recommencement of antennation indicated stylet withdrawal. It is possible to use these indirect indicators of stylet penetration to study behavioural effects of antifeedants on unrestrained aphids.

APHID FEEDING DETERRENCY BY HYDROXAMIC ACIDS IN WHEAT SEEDLINGS DECREASES VIRUS TRANSMISSION. Hermann M. Niemeyer, Arturo Givovich (Departamento de Química, Facultad de Ciencias, Universidad de Chile, Casilla 653, Santiago, Chile)

Numerous correlations between hydroxamic acid (Hx) concentrations in wheat plants and aphid performance have suggested a major role for Hx in aphid resistance through antibiosis. Electric monitoring of aphid feeding behavior of the aphids on wheat seedlings with different Hx levels, coupled with analysis of phloem exudates and of aphid honeydew, showed that hydroxamic acids act also as feeding deterrents. This property plays a key role in the transmission of the barley yellow dwarf virus to wheat.

Homopteran Feeding Behaviour: Recent Research Advances and Experimental Techniques

AMINO ACIDS AND PROTEINS AS CUES IN PLANT-APHID INTERACTIONS. Yvan Rahbé, G. Febvay, B. Delobel (INRA - Laboratoire de Biologie Appliquée INSA 406, 20 ave A. Einstein, F 69621 Villeurbanne, France)

Amino-acids are among the numerous cues governing host-plant acceptance by aphids, through immediate or delayed behavioural and nutritional effects. Proteins are encountered by aphids along the whole process of plant penetration and feeding; their action on aphid behaviour and physiology is practically unknown. The functions of these two biochemical compartments on aphid feeding will be reviewed, with special emphasis at the molecular level of the interaction and its consequences on the analytical and behavioural methodologies.

AC-ELECTRONIC MONITORING AND ITS ROLE IN VIRUS-VECTOR RELATIONS OF CICADELLIDS. Peter G Markham (Department Virus Research, John Innes Institute, Colney Lane, Norwich, Norfolk, NR47UH, U.K.)

An understanding of virus-vector relationships results from investigating the three components (the virus, the vector, the plant) and the complex of interactions that take place between them. Electronic monitoring systems (EMS) can provide information on feeding behaviour and when used in conjunction with bioassays, help to elucidate those events which are required for successful virus transmission. An AC-EMS was used to study leafhopper transmission mechanisms involved with the circulative geminivirus, maize streak virus (MSV) and the semi-persistent virus complex of rice tungro disease (RTD).

The objective with the vector of MSV, *Cicadulina mbila*, was to investigate the high acquisition efficiency from maize but inconsistent virus acquisition from some grasses. *C.mbila* was a phloem feeder on most preferred monocotyledonous hosts but failed to find or sustain feeding in the phloem of rice, a non-preferred host. However on MSV-infected maize, initial feeding was from mesophyll cells from which MSV was most likely to be acquired. Feeding in the phloem was essential for transmission. Different maize cultivars also invoked changes in feeding preferences. The application to RTD was not only to investigate "typical" feeding responses but to develop feeding solutions for *in vitro* acquisition experiments to study the relationship between the two viruses and the vector, *Nephotettix virescens*. *In vitro* acquisition was efficiently (62%) accomplished for both RTD and the spherical viral component of RTD.

INFLUENCE OF SUITABLE AND UNSUITABLE PLANTS AND THEIR EXTRACT ON THE FEEDING BEHAVIOR OF *NEPHOTETTIX VIRESCENS* DISTANT. Jianjun Liu* and Shozo Takahashi (Pesticide Research Institute, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan. * Present address: Biological Control Institute, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

A rice variety 'Nihonbare' was selected as a suitable and *Leersia hexandra* as an unsuitable plant for *Nephotettix virescens* by the value of intrinsic rate of increase. The feeding behavior on both plants was investigated through analysis of honeydew composition and recording of ingestion pattern through an electronic measurement device (EMIF). Although a certain amount of honeydew was excreted on both plants, there was less sugar content and no sucrose in the honeydew from unsuitable plant. No phloem ingestion waveform was recorded on the unsuitable plant absolutely. The influence of the extract from both plants on the survival and feeding behavior of *N. virescens* was investigated. The water soluble extract of unsuitable plant caused high mortality in *N. virescens*, while that of suitable one did not. The basic fraction of water soluble extract was proved to be major ingredient. The amphoteric fraction was found to be beneficial for its survival. Feeding behavior recorded on EMIF showed that the ingestion duration of *N. virescens* became shorter when the basic fraction was added to the sucrose solution as compared with sucrose alone or with amphoteric fraction added. An phloem ingestion pattern was recorded when *N. virescens* fed on sucrose solution added with the amphoteric fraction.

INTERPRETATION OF AC ELECTRONIC FEEDING MONITOR WAVEFORMS FROM TWO SPECIES OF WHITEFLY, *BEMISIA TABACI* AND *PARABEMISIA MYRICAE*. G. P. Walker, T. M. Perring (Department of Entomology, University of California, Riverside, California 92521, U.S.A.)

Behaviors of adult *Bemisia tabaci* feeding on bean and *Parabemisia myricae* feeding on rough lemon were studied using an AC electronic feeding monitor. Standard fine gold wire (12.5μ diameter) was not pliable enough for these small insects and greatly impeded their mobility. Satisfactory results were obtained with ultra-thin 1.25μ Wollaston process platinum wire. Electronic waveforms for the two whitefly species were correlated with the position of the stylet tips using histological techniques and observations of the pattern of honeydew production.

SEXUAL COMMUNICATION AND THE SOUND-PRODUCING ORGAN OF THE WHITE-BACKED PLANTHOPPER. Zhi-hua Ye (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China), R.C. Saxena (International Rice Research Institute, P.O.Box 933, Manila, Philippines), Zhi-tao Zhang (China National Rice Research Institute, Hangzhou 310006, China)

Sound production by males of planthoppers other than cicadas has been known since the 1940's. Further investigation of acoustic behavior in planthoppers demonstrated that both sexes were able to produce sounds during courtship. Experimental observations indicated that such courtship signals were transmitted through substracts. However, the mechanism of sound production in delphacids puzzled many workers. An appropriate explanation was lacking until a sound-producing organ was discovered in the brown planthopper, Nilaparvata lugens (Stål). We have recently examined the sound production in the whitebacked planthopper, Sogatella furcifera (Horváth). Our observations on the courtship process of S. furcifera adults suggest that, in planthoppers, sexual recognition and communication depend entirely on hearing rather than on vision. We also report the presence of a stridulating organ in S. furcifera adults, which has led us to conclude that similar organs may occur in other delphacids.

RECORDING AND ANALYZING INSECT BEHAVIOR: A TECHNOLOGICAL REVIEW.
L.P.J.J. Noldus (Noldus Information Technology bv, Costerweg 5, Wageningen, The Netherlands)

The question which parameters must be measured and how data are to be collected and analyzed forms an integral part of any experimental study of insect behavior.

Classical ethology treats behavior as a stream of events, scored according to a predefined ethogram. This is the method of choice in any experiment where detailed behavioral information is crucial, e.g. when observing mating, host-plant selection, or parasitoid-host interactions. Methods for real-time recording of discrete behavioral events have evolved from paper-and-pencil methods and mechanical strip-chart recorders to flexible software systems based on off-the-shelf microcomputers. In studies of insect migration or olfactory orientation, accurate spatio-temporal information may be more important than behavioral events *per se*, and automatic tracking systems are increasingly used for this purpose. Video tracking is in rapid development as a powerful tool to record the path of a moving insect in 2- or 3-dimensional space (e.g., olfactometer, locomotion compensator, wind tunnel). Besides video image analyses, digital sound analysis is also coming of age. This technique allows the researcher to record and analyze not just the occurrence but also the acoustical properties of insect communication signals.

Behavioral events are most often described in terms of frequency of occurrence, duration and latency. In addition, concurrent and sequential relationships can be quantified. These analyses can also be applied to track (path) or sound data, after reduction of continuous series of samples (e.g. spatial coordinates) to discrete events. Furthermore, the growing availability of accurate digital measuring devices allows the integrated analysis of discrete behavioral events and simultaneously recorded continuous signals, such as physiological data or environmental parameters.

Finally, the increasing processing power, and interactive and graphical capabilities of desktop computers open fascinating avenues for analyzing and understanding the complexity of insect postures, acts, movements and acoustic signals in relation to their internal physiology and external environment.

HOW TO BIOASSAY OLFACTORY ATTRACTION IN THE LABORATORY.
J.H. Visser (Research Institute for Plant Protection IPO-DLO, P.O. Box 9060, 6700 GW Wageningen, The Netherlands)

Bioassays of insect responses to odour stimuli arising from food or conspecifics, should cover three questions: (1) does the insect respond to the odour, (2) how does the insect respond to the odour, and (3) what is the benefit for the insect? The design of an instrument to measure insect responses to odours, to such instrument is generally referred as an olfactometer, starts with the appreciation of insect characteristics for orientation behaviour such as speed of locomotion, walking or flying, responses to visual and mechanical stimulation, circadian rhythm and motivation. Each olfactometer designed, favors, through its physical dimensions and spatial distribution of the odour, particular insect responses like a change in speed of locomotion or in rate of turning (kineses), a change in the direction of locomotion (taxes), or triggers the response to another stimulus modality such as wind (positive anemotaxis). In Y-tube and four-armed olfactometers, insect preference for a particular odour results from a mix of different responses, and, thereby, the interpretation of such experiments is limited. In wind tunnels, an attractive odour releases positive anemotactic responses which for flying insects are guided by optomotor feedback. For walking insects a locomotion-compensator enables the dynamics of insect orientation to be analyzed as a system controlled by internal and external information. Insect orientation is, thus, appreciated as a flexible response that copes with changes in the insect and its environment. Insects can increase the probability of encountering food or conspecifics by olfactory orientation. However, the fitness of such behaviour, the benefit for a particular insect genotype, needs further research.

AN AUTOMATED APHID FLIGHT CHAMBER.
Jim Hardie (AFRC Aphid Biology Group, Imperial College at Silwood Park, Ascot, Berks SL5 7PY, U.K.)

A flying aphid is attracted to a light source placed above the chamber but the insect's upward progress is prevented by a down-draught of air. The flight path is observed by a video camera looking into the chamber, the aphid's position is monitored by a teletracker and the positional co-ordinates fed into a microcomputer. The microcomputer uses the height of the flying aphid to servo-control the wind speed so as to hold the insect at the level of a translucent target screen (5 cm diam.) in one side wall. It initiates target presentation by back-illumination of the screen with a plant-green light for 2.5 seconds during each minute of flight and logs the aphid's horizontal flight path which is used in the behavioural analysis of target attraction. The interaction of visual and odour cues can also be examined.

ARE OLFACTOMETERS STILL VIABLE?
Masayuki Sakuma (Pesticide Research Institute, Kyoto University, Japan)

Critics made examples of olfactometers and choice-chambers as typical 'undiscriminating assays', which permit several types of behavioral response to occur simultaneously, leaving each contribution unmeasured. Nevertheless, before abandoning this device altogether, I would like to point out some possibility for improvement. I modified a classical T(Y)-tube olfactometer by furnishing a T-wire pathway detached from the wall surface, so that the test animals can choose a direction at one point where the stimulus condition is standardized. Constraint in a linear movement on the wire provides a controlled introduction of animals into a given stimulus polarity of air current or odour concentration gradient. Chemotaxis and odour conditioned anemotaxis in *Blattella germanica* nymphs to aggregation pheromone were demonstrated in different air flow modes. I observed different dose/response patterns between these two taxes, which would reflect the chemo-orientation strategy. Although the linear pathway sacrificed observation of behavioral programs, such as oscillation of zig-zagging, I could estimate the stimulus potency precisely, which must be a major interest for a chemist. From this point of view there will be room for olfactometers in insect behavioral research still in the future.

REAL-TIME DETECTION OF MOVING INSECTS ON AN IRREGULAR BACKGROUND WITH A GENERAL-PURPOSE IMAGE ANALYSIS SYSTEM.
F. Marion-Poll, E. Bakchine-Huber, L. Kaiser, M.-H. Pham-Delègue, C. Masson (LNCI, INRA-CNRS, BP 23, 91440 Bures-sur-Yvette, FR), F. Soussaline (IMSTAR, 60 rue ND des Champs, 75004 Paris, FR)

General-purpose image analysis systems are supported by low-cost microcomputer platforms. Most available applications are devoted to static data (micrography, morphometry and 2D-gel analysis) but are generally considered as inadequate for analysis of kinematic data.

We have developed a software system to track insects moving in a closed area (available from IMSTAR). Two different problems were addressed. First, real-time tracking (up to 25 frames/s) involved the development of device-specific assembly routines. Background independency and unequal time sampling were found necessary features to cope with different experimental devices and insects. Then, recorded data were subjected to classical track analysis and mapping display. Classical methods proposed so far consider individual tracks from which different parameters are extracted. Given the number of repetitions necessary to extract relevant parameters from a given experiment and the variety of olfactometers used, we propose to display results as density maps. This approach correlates any parameter (e.g. presence density) with the specific distribution of a stimulus in the experimental area.

Applications of this approach are illustrated on experimental data obtained on honeybees and parasitoid wasps in a four armed olfactometer.

THE OBSERVER 3.0: A FLEXIBLE SYSTEM FOR COMPUTER-AIDED RECORDING AND ANALYSIS OF INSECT BEHAVIOR.
L.P.J.J. Noldus, J. Jansen & M.D. Pluim (Noldus Information Technology bv, Costerweg 5, Wageningen, The Netherlands)

The Observer is an integrated software system for the collection and analysis of behavioral data. Since the introduction of version 1.0 of the program in 1988, The Observer has become established as a standard instrument in insect behavior research. Based on user feedback, an updated version 2.0 was released in 1990. The current presentation addresses the progress that has been made since then, which has resulted in version 3.0 of the system.

The system is fully menu-driven and intuitively understandable. The user specifies options in settings screens in the configuration module. The configuration can be used directly for event recording on the PC, or transferred to a handheld computer for data collection in the field.

An event-recording configuration is the coded representation of an ethogram. Single keys or combinations of keys can be designated as *events* (changes in behavior, posture, location, etc.), and *modifiers* can be used to record elements associated with an event (substrate, direction, object, intensity, etc.). Both events and modifiers can be grouped in independent *classes*, within which a practically unlimited number of mutually exclusive elements can be defined. The observation of multiple individuals has been improved by the introduction of the concepts of *subjects*, which are initiators or receivers of behavior, and *channels*, which are unique combinations of focal subjects and classes of events, for which a complete behavioral record is obtained.

During event recording, behavior is scored as a sequential stream of events. To facilitate data entry from videotaped records, the timer can be adjusted manually and timing can be suspended and resumed during the observation. The user can customize the layout of the event-recording screen as well as the level of error checking and auditory feedback. Various data storage options minimize the loss of data due to hardware or power failures.

The Observer calculates descriptive statistics for selected events and/or user-definable event- or time-based windows in time. The system also provides integrated analysis of behavioral events with continuously measured environmental data. Data can also be presented graphically on screen or printed on paper. Other options are interobserver reliability and lag-sequential analysis.

VIDEO ANALYSIS OF TSETSE FLY BEHAVIOUR IN THE FIELD. John Brady, Gabriella Gibson, Mike Packer & Nigel Griffiths (Biology Dept., Imperial College, Silwood Park, Ascot, Berks - SL5 7PY - U.K.)

We first demonstrated the possibility of video-recording flying tsetse flies in the wild in 1983. We then used a Link 109A 12-V camera with plumbicon tube and Fujinon auto-iris wide-angle lens, but now use a Cohu CCD camera with a similar lens, recording on a portable Sony U-matic vtr, superimposing a 0.01-s time-base (Fora VTG22). Playback analysis is on a Sony mains recorder (VO-5800PS) with shuttle-search and stop-frame, and a high resolution b/w monitor (Hitachi VM-129). Setting up in the field is with a portable b/w monitor (Prostab).

Video images of flies are clearest against a black background, but with CCD cameras can also be seen against smooth natural backgrounds such as sand, or coloured cloth (e.g. on trap surfaces). With the camera looking vertically down at a black groundsheet, tsetse flies can be distinguished from other insects at up to ~3 m, on the basis of image size, speed (4-8 m s^{-1}) and track shape (confirmed by contemporary catches of flies). This makes a maximum observable, pyramidal flight space 3-m high, subtending ~2.5 x 3m at ground level.

Tracks are digitized frame-by-frame (lab-made digitizer) and then computer analyzed for: flight speed, turn diameters, angular velocity of turns, interactions between flies, approaches to visual targets, landing sites, flight angle to wind, relationship with odour plumes, etc.

A VIDEO TRACKING SYSTEM FOR RECORDING AND ANALYZING INSECT MOVEMENT IN 2- OR 3-DIMENSIONAL SPACE. L.P.J.J. Noldus, J.B.I. Rousseau, M.J.A.J. Wegman, W. Takken[1] & B.M. Spruijt[2] (Noldus Information Technology bv, Costerweg 5, Wageningen, The Netherlands; [1]Department of Entomology, Wageningen Agricultural University, Wageningen, NL; [2]Rudolf Magnus Institute, University of Utrecht, Utrecht, NL)

Studies of insect behavior in which accurate spatial information is required and/or which are too time-consuming for a human observer demand a high level of automation. Technology for automatic collection of behavioral data is in rapid development. In particular, video imaging techniques are becoming increasingly important.

We have developed a general-purpose video tracking system which automatically records the movement of animals in 2- or 3-dimensional space, observed by a video camera. On the basis of raw X-Y or X-Y-Z coordinates, the program calculates a variety of statistical parameters, including velocity, distance travelled, time spent in user-defined zones, angular velocity, etc. In addition, the program includes routines for graphical reconstruction of the locomotory path and the observed arena on the computer screen. The user can alter the viewpoint, zoom in and out, and rotate the image on the screen, and obtain publication-quality hardcopy on paper. During real-time operation, the number of images processed/sec largely depends on the speed of the host PC. Execution speed is also affected by the ratio between the size of the insect and the size of the experimental arena under observation. With off-line data acquisition, by retrieving images from a computer-controlled VCR, a temporal resolution equal to full video speed can be achieved. Besides tracking individual insects, the system can also follow the movement of several individually recognizable and interacting arthropods.

The system has been designed for maximum flexibility in data collection and analysis. It can be configured for many different experimental set-ups, such as olfactometers and wind tunnels, observations of foraging behavior and patch-time allocation in semi-natural settings, etc. The presentation will include a demonstration of the software on a PC as well as a discussion of the use of the system for the study of olfactory attraction in malaria mosquitoes.

Monitoring beetle movements in the field using the harmonic radar.

Henrik Wallin,(Swedish University of Agricultural Sciences Dept. of Plant and Forest Protection, P.O. Box 7044, S-75007 Uppsala, Sweden.)

A detection system based on harmonic radar with reflector has been successfully used to study the behavior of highly mobile (nocturnal/ diurnal) arthropod predators. Electronic diodes are glued to the insects, and reflect microwave beams emitted by the portable detection equipment. A new version of the apparatus is presented, and examples of field-tracking results are shown. Possibilities for future improvements in the equipment for identifying indivi-duals are discussed.

ANALYSIS AND MODELLING OF INSECT MOVEMENT AS RANDOM WALKS: THE PERVASIVE INFLUENCE OF HETEROGENEITIES IN THE ENVIRONMENT. *Jérôme Casas* (Swiss Institute of Technology ETH, Zürich, Switzerland), Martin Aluja (Institute of Ecology, Xalapa, Mexico), Stephan Blanché (ETH, Zürich, Switzerland), Ronald Prokopy (University of Massachusetts, Amherst, USA).

Although the statistical analysis and the modelling of insect movement based on random walk theory has made substantial progress in the last decade, two assumptions remained almost unchallenged: the homogeneity of the environment and the nearest neighbour hopping mechanism. This paper deals with the paths of insects foraging in realistic conditions where heterogeneities in the environment prevail. For illustration, we use four case studies covering a broad range of situations. First, the tracks of a leafminer parasitoid searching on leaves with mines is analysed and modelled. Thereby, the influences on the foraging outcome of, different angle distributions on the leaf lamina, on the mine, of correlations between steps and of an abrupt change of behaviour at the mine border are illustrated. Secondly, considering a complete lattice structure, we then show the border effect on *Trichogramma* searching on a group of eggs. Thirdly, we consider the apple maggot *Rhagoletis pomonella* foraging in an apple tree as a particle moving in an 3-D incomplete lattice structure. The tree architecture partly determines the probability to reach an apple in a given time, for example. Finally, we consider leafminer parasitoids searching within apple trees: the assumption of nearest neighbour hopping mechanism is invalid and their paths are best modelled as random walks on graphs.

A recurring challenge is to distinguish the part of the dynamics which is due to the underlying random walk from the part attributable to the geometry of the system. Meeting this challenge is a prerequisite to extending the domain of applicability of the results to environments other than the ones mapped.

MATING BEHAVIOR OF THE CRYPTOMERIA BARK BORER, SEMANOTUS JAPONICUS (LACORDAIRE). Fauziah A.(Institute of Advanced Studies University of Malaya, 59100 Kuala Lumpur, Malaysia),K. Ito & K. Tabata (Kansai Forestry and Forests Products Research Institute Fushimi-momoyama, Kyoto, Japan),S, Takahashi (Pesticide Centre, Fac. of Agriculture, Kyoto University and T. Hidaka(Dept. of Zoology, Fac. of Science, Kyoto University, Kyoto 606, Japan).

Mating behavior of the cryptomeria bark borer, Semanotus japonicus, was studied using glass container, wind tunnel and T-shaped olfactometer. The mating sequence showed that an olfactory cue was emitted by female and that it was effective at close range . Choice test using T-shaped olfactometer showed a significant preference to female odor by the male whereas females were not attracted to female nor female odor. Removal of antenna and blinding in male delayed copulation, while similar treatment did not have any effect on female. Male did not show copulatory attempt even after contact with the female washed with hexane. Male tried to copulate with the glass rod impregnated freshly or 7 days earlier with female surface and abdominal rinse. This suggested that some substance on the female body surface is responsible for eliciting copulation and the substanceon the female body surface is responsible for eliciting copulation and the substance is stable and not volatile

Key words: Olfactory stimuli, close range, female body surface, sex pheromone

MATING BEHAVIOUR OF DYSDERCUS KOENIGII F. AND ROLE OF ANTENNAE IN MATE - FINDING AND RECOGNITION S.S.SEHGAL, K.K.GUPTA (Department of Zoology, University of Delhi, Delhi-110007, INDIA)

Dysdercus Koenigii. exhibits a complex sequence of events in the process of reproduction. Some characteristic features observed in the reproductive behaviour of Dysdercus were: After the emergence, both the sexes took three days to become sexually active. The adults copulated 5-7 times in their entire life. The first mating lasted for 72 hrs after which the female laid its first batch of eggs. Soon after, the female again entered into a copula. The duration of the subsequent matings graually shortened to 24 hrs. The copulation period in these matings was governed by age and reproductive physiology of the female. The male physiological status appeared to have no influence on it. A sexually mature male exhibited certain courtship behaviours before assuming an end to end mating position. The visual cues apparently played no role in mate-finding and recognition as neither blinding of the male nor alteration of colour pattern of the female affected the courtship and mating behaviours. In contrast, antennectomy of male incapacitated it to exhibit these behaviours. Also, the males responded to the presence of surface extract of a female (probably a pheromone) which they failed to respond to in the absence of antennae. A male also responded to the surface extract of another male, showing the extract was not sex specific and this appeared to be a reason for homosexual mounting which was often seen in culture.

PHYSIOCHEMICAL, NUTRITIONAL AND BEHAVIORAL CONSIDERATIONS FOR MASS REARING OF TEPHRITID FRUIT FLIES. Eric B. Jang, Harvey T. Chan, Jr. (USDA-ARS, Tropical Fruit and Vegetable Research Laboratory, P. O. Box 4459, Hilo, Hawaii 96720, USA)

Tephritid fruit flies have shown tremendous behavioral plasticity in oviposition, larval rearing and pupation which has allowed for the development of production-scale mass-rearing technology. Knowledge of each of these behaviors have enabled insect production workers to rear several hundred million flies per week. Further improvements, however, will require careful consideration of the physiochemical and nutritional factors involved in large scale mass rearing of fruit flies. Physiochemical factors such as pH, osmolarity and temperature are important in larval development and nutrient assimilation. The precise nutritional requirements of tephritid larvae are largely unknown. Quality of mass-rearing flies is dependent on all of the above factors and should not be compromised for mere numbers of insects reared. Behavioral quality control tests should reflect the ability of mass reared flies to perform well in the field.

LIFETIME REPRODUCTIVE SUCCESS IN DRAGONFLIES. David J Thompson (Department of Environmental & Evolutionary Biology, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, U.K.)

There are more studies of mating or reproductive success of dragonflies than of any other insects; their size and ability to be marked and watched renders them particularly suitable for such studies.

Laboratory studies on feeding and development rates of larvae indicate that well-fed larvae moult into larger animals and do so sooner than poorly fed individuals.

This trend is reflected in a decline in size at emergence through the season and in those adults arriving at a particular rendezvous to breed.

For many early emerging species the best weather for reproductive activity is at the end of their flying period, a time likely to be encountered by smaller adults. Weather is known to have a major influence on lifetime reproductive success of dragonflies.

It seems then that the "best" larvae, those that emerge first, suffer reduced reproductive activity because later emergers experience better weather and consequently obtain more matings.

The present paper explores this apparent paradox and attempts to resolve it.

OVIPOSITION STIMULANTS OF SWALLOWTAIL BUTTERFLIES: THE ROLE OF FLAVONOIDS

Ritsuo NISHIDA (Pesticide Research Institute, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan)

A large number of swallowtail butterfly species are strongly associated either with the Rutaceae or Aristolochiaceae. The females lay eggs with great precision on their own hosts, detecting specific plant chemicals through the tarsal chemoreceptors. Oviposition stimulants of a Rutaceae-feeder, *Papilio xuthus*, characterized from a *Citrus* plant were a mixture of ten hydrophilic components which included flavonoid glycosides, a cyclitol, and basic and zwitter-ion compounds. A similar subset of stimulant flavanone glycosides was also found in a host plant, *Xanthoxylum piperitum*. In contrast, a non-host rutaceous plant, *Orixa japonica*, was found to contain an oviposition deterrent flavonoid in the leaves.

Aristolochic acids have been identified as the less polar stimulant components for a troidine species, *Atrophaneura alcinous*. Flavonoids did not seem to contribute as the stimulants, although the host *Aristolochia* leaves contained substantial quantities of flavonoids. However, one of the oviposition stimulant of a zerynthiine Aristolochiaceae-feeder, *Luehdorfia japonica*, was characterized as a flavonol triglycoside from its host plant, *Heterotropa aspera*.

Oviposition stimulants of swallowtails so far identified appeared to consist of multiple components, and flavonoids seem to play an important role as key ingredients for most of these species, suggesting a common phytochemical background of host recognition amongst the Papilionidae.

A MAJOR BARRIER IN DEVELOPING ARTIFICIAL DIETS FOR YELLOW RICE BORER, *SCIRPOPHAGA* (*TRYPORYZA*) *INCERTULAS* (WALKER). Yan-nian Wang, Zhong-qing Zheng, Jin-lin He, Pei-fu Guo (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China)

From the early 1960's to 1980's, entomologists from Japan, China and Southeast Asian countries tried to use different artificial diets in rearing this monophagous insect. But all of these failed because of high larval mortality at the beginning of rearing. Through repeated testings, we found that feeding deterrent factor present in some dietary components was a major barrier. Among ten's of components tested, brewer's yeast, wheat germ, defatted soybean, linolic acid, ascorbic acid, etc. ingredients which were used frequently in the formulation of insect artificial diets all resulted in obvious feeding inhibition to newly hatched larvae. After suitable treatment and choice of the components, the diets developed were acceptable to *S. incertulas* larvae and a mean 95% survivorship of young larvae was obtained.

VIRULENCE OF LARVAE OF THE ASIAN CORN BORER OSTRINIA FURNACALIS (GUENEE) REARED FOR DIFFERENT GENERATIONS ON A SEMI-ARTIFICIAL DIET TO A SUSCEPTIBLE HYBRID. Zhen-ying Wang, Da-rong Zhou(Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Larvae of the Asian corn borer Ostrinia furnacalis(Guenée) (ACB), reared for 12, 24, 32, 48 and 71 generations on a semi-artificial diet developed by the authors, were used to compare their virulence to a F_2 generation larvae after artificially infested to a susceptible corn hybrid—Zhongdan No.2. No significant differences in virulence were found among these testing insect materials as indicated by the leaf feeding damages induced. Similarly, no significant differences in stalk damages caused by larvae reared for 24, 37, 45, 61 and 84 generations on the same diet to the same hybrid were observed. It was thus concluded that the ACB reared on the particular diet for 6 to 7 years can still be used for field infestations in resistance evaluations, although Guthrie et al. reported that the European corn borer O. nubilalis (Hübner)(ECB) reared on a meridic diet for 14 generations would eventually lose their virulence to susceptible corn materials.

DOUBLE HELIX OF INSECT ANTENNAE AND CHIRALITY. Yieng-shing Chow, Chern-feng Yen, Hsiao-Yung Ho (Institute of Zoology, Academia Sinica Taipei, Taiwan 11529, China)

A local blister beetle *Epicauta hiricornis* Haug-Rutenberg has a special pre-copulatory behaviour, when the male is dorsal riding on the female, the male antennae continuously waving to the female antennae side to side and sometime he can grasp her corresponding antennae forming a double helix structure. The chance to form a right-handed or left-handed spiral antenna complex are equal. If the female left antenna is not available, the male antenna will wind the female antenna to the right, or vice versa. When both male and female antennae are held tight, the pair antennae vibrates in a frequency 7-12 c/s like that sex display of wing fluttering in male moth to his mate. The blister beetle was used as an aphrodisiac drug in Chinese medicine for many years, its connection with cantharidin was also discussed.

ETHOLOGICAL ANALYSIS AND SIMULATION OF BEHAVIOUR AS A TOOL IN APPLIED ENTOMOLOGICAL RESEARCH

Slawomir A. LUX (International Centre of Insect Physiology and Ecology, P.O. Box 30772, Nairobi, KENYA)

Many failures in application of IPM methods can be attributed to gaps in our knowledge about insect behaviour. This results in a growing demand to employ ethological methods to bioassays used in applied research.

A set of integrated computer programs for ethological analysis was presented. The set is composed of programs for: (1) observation and quantitative analysis of behaviour (calculation of durations and frequencies of each activity as well as probabilities of transitions between them - input and output chances), (2) creating time budget charts (percentage of time spent for each activity during observation), (3) simulation of behaviour (dynamic, stochastic model simulating behaviour of a single individual, using only statistical parameters of clear biological meaning, taken from ethological analysis), (4) statistical analysis and comparison between two sets of ethological data or two time budget charts (e.g. experimental and simulated ones).

Quantitative description of insect behaviour, verified by simulation, is a precise tool for revealing and analyzing even subtle behavioural response.

PROPENSITY OF MULTIPLE MATING IN FEMALE DYSDERCUS KOENIGII: THE ADAPTIVE SIGNIFICANCE. K.K.GUPTA, S.S.SEHGAL (DEPARTMENT OF Zoology,University of Delhi, Delhi-110007, INDIA)

One of the remarkable features in the reproductive behaviour of Dysdercus is that the female mates 5-7 times in its life span and spends a major part of its life in copula. Our observations indicate that multiple mating furnished the female with male conspecific substances which increased the reproductive potential of the female. As compared to a virgin female, a mated female exhibited shortened preoviposition period and enhanced fecundity. Also the mating affected the oviposition behaviour and imparted an accelerated oocyte growth. The interoviposition period in a virgin female was 7-8 days as compared to 5-6 days in singly mated female and 2-3 days in the females mated several times. The size of egg-batches in all the three groups was almost same but the number of egg batches laid by multiply mated females were significantly greater, which thus accounts for a high fecundity in the multiply mated females. The multiple matings might have helped the female in sperm replenishment as indicated by a high hatchability of all the egg-batches. On the contrary, the hatchability diminished gradually in the egg-batches derived from a singly mated female in its later life.

ONTOGENY OF *PRIONOMITUS MITRATUS* DALM. (HYM.: ENCYRTIDAE) ON PEAR *PSYLLA PYRI* L. (HOM. PSYLLIDAE).

Assadollah Aghamirkarimi (P.O. Box 11365/7117, Aboureyhan Tehran-Iran)

In this investigation, the embryonic development incubation period, feeding habits of larvae, respiration, mumification of host body and the behaviour of parasitized host will be discussed.

APPLICATION OF BIOTHECNICAL METHOD IN PEST MANAGEMENT. E. F. Kozarzhevskaya (Main Botanical Garden Academy of Sciences, 127276, Moscow, Russia)

Biothecnical method is ecological strategy in pest management, based on insect behaviour, their natural reactions and physiology processes of metamorphosis under influence of optical and acustical alarms, attractants, pheromones and insect growth regulators. Coloured traps, developed by Main Botanical Garden Academy of Sciences, showed high level of activity against whiteflies, winged aphids and ants, onion fly, reducing the population of these pests. The best results obtained from combination: coloured traps with new Japanese insect growth regulator-Applaud 25 WP (Nihon Nohyaky), coloured traps with bioagent - encarsia- or entomopathogenic fungi-verticilium against whiteflies and coloured traps with attractants against flies. Using behaviour of insects in selecting the host- plant and their reaction on colour is very perspective for future Integrated Pest Management.

STUDIES ON THE BEHAVIORAL BIOLOGY OF FIRST AND SEÇOND GENERATION ADULTS OF THE ASIAN CORN BORER, OSTRINIA FURNACALIS(GUENEE). Wen-de Li, Su-xin Chen,Shu-fa Zhang(Zhangjiakou Technical College of Agriculture, Hebei, 075131, China), Bi-xian Li, Li Zheng,Yong Liou, Shu-lan Gao, Guang-yi Zhang(Dry Farming Institute, Hebei Academy of Agricultural and Forestry Science, Hengshui, Hebei, 053000, China), shao-yin Li(First Vocational School of Zunhua, Hebei, China)

Studies were carried out in the fields and laboratory in different areas in Hebei. The emergence peak of both generations adults of the Asian Corn Borer(ACB) occurred at 20h00 to 22h00. The duration of adults before mating averaged 28h for females and 28h32min for males. The average oviposition peak of lst generation females was at 21h00 to 22h00 and more eggs were laid at 22h00 to 23h00 comparatively by 2nd generation females. In 2-generation areas in Hebei, 75.6-100% of the mating pairs of lst generation adults were observed in the rice fields, and mating activities occurred mainly in the millet, peanut and soybean fields where there was no rice planted. In 3-generation areas in Hebei, the adults of 2nd generation mated mainly in the summer-sown soybean and summer-sown millet fields. The resting locations of the ACB adults were almost identical with the mating locations. The flying activities of both generations adults between the corn fields and the mating locations showed regular patterns. The mating pairs in the fields presented a significant aggregated dispersion.

Interspecific attraction and inhibition in four species of *Ips* bark beetles

Göran Birgersson, Chemical Ecology, Göteborg University, S-413 20 Göteborg, Sweden, Mark J. Dalusky, Karl E. Espelie, and C. Wayne Berisford, Dept. of Entomology, University of Georgia, Athens, GA 30602, U.S.A.

Hindgut extracts from *Ips avulsus*, *I. calligraphus*, *I. grandicollis*, and *I. pini*, were analysed by combined gas chromatography and mass spectrometry. The recently identified compounds lanierone and *E*-myrcenol were found in extracts of *I. avulsus* and *I. pini*, and in *I. grandicollis* and *I. pini*, respectively. In addition, geraniol was found in most species. Chiral analyses were made on ipsdienol and ipsenol.

Synthetic compounds were tested in a field trap bioassay. *I. avulsus*, *I. calligraphus*, and *I. grandicollis* were trapped on the coastal plains in and the Piedmont of Georgia, and *I. avulsus* and *I. pini* in the south of the Appalachian mountains.

A strong interspecific attraction was found between *I. avulsus* and *I. pini*, based on ipsdienol and lanierone. The attraction of *I. grandicollis* to its own mixture was strongly inhibitited by ipsdienol, while *E*-myrcenol was inhibitory to most species.

FEMALE SEX PHEROMONE OF HELIOTHIS ASSULTA GUENEE: MALE BEHAVIORAL RESPONSE IN FLIGHT TUNNEL AND FIELD TESTS. Jian-ping Cai, Meng-ying Liu(Institute of Zoology, Academia Sinca, Beijing 100080, China)

n-Hexane of extracts of ovipositor of female H. assulta contained 6 compounds: Hexadecenal(16:Ald), (Z)-9-Hexadecenal(Z-9-16:Ald), (Z)-11-Hexadecenal(Z-11-16:Ald), (Z)-9-Hexadecen-1-ol(Z-9-16:OH), (Z)-11-Hexadecen-1-ol(Z-11-16:OH) and (Z)-9-Hexadecenyl acetate(Z-9-16:OAc). These compounds are analogous to known H. spp. sex pheromones. In order to confirm the action of attractant components, flight tunnel and field tests were conducted with the synthetic chemicals in different combinations and ratios. The results indicated that the binary mixture of Z-9-16:Ald and Z-11-16:Ald(10:1) showed the highest attraction to male moths, that was similar to the virgin females. The presence of Z-9-16:OH or Z-7-16:Ald in the binary mixture significantly reduced male moth captures. The results were consistant in both laboratory tunnel and field tests.

A SEX ATTRACTANT FOR LEOPARD MOTH *ZEUZERA PYRINA* L. (LEP. ZEUZERIDAE). Morteza Esmaeili, A. Ghaderi and S.M. Sajjadi (Plant Protection Dept., College of Agriculture of Tehran University, Karaj 31584 Iran)

A sex pheromone for attracting male leopard moth *Zeuzera pyrina* L. is tested for four years and it is found that this substance can be used for direct control of this important pest of apple and walnuts in Iran.

RECENT ADVANCES IN THE SEX PHEROMONES OF SCARAB BEETLES. Walter Soares LEAL (Department of Insect Physiology and Behavior, National Institute of Sericultural & Entomological Science, 1-2 Ohwashi, Tsukuba, 305 Japan)

The sex pheromones of *Popillia japonica* NEWMAN and *Anomala rufocuprea* MOTSCHULSKY have been successfully applied in Japan for monitoring of these pest, and envisaged to be a safer alternative to conventional pesticides. Nevertheless, the identification of sex pheromones of other economically important pests have been precluded by the lack of appropriate bioassays. In order to alleviate that, GC-EAD was adapted to use with lamellate antennae as a complementary technique to very simple bioassays. As a result, the characterization of new sex pheromones was accomplished. *Anomala cuprea* HOPE utilizes (R,Z)-5-(-)-(oct-1-enyl)oxacyclopentan-2-one, which is markedly similar to the pheromones of the beetles aforementioned. On the other hand, *Holotrichia parallela* (MOTSCHULSKY) uses a unique sex pheromone as will be discussed along with other recent findings.

PHEROMONAL TRAPS - A TOOL FOR MONITORING PEST POPULATION OR JUST FOR TRAPPING INSECTS ?

Slawomir A. LUX (International Centre of Insect Physiology and Ecology. P.O. Box 30772, Nairobi, KENYA)

We can not eradicate all pests, so we have to learn how to live with them or rather how to effectively compete with them. Applying any control means is reasonable only above certain level of population density, which requires quantitative monitoring methods. However, results obtained with pheromonal traps are frequently misleading because of lack of well defined standards for their interpretation. We have to realize, that what we are monitoring is just intensity of searching for females. In vast majority of cases we know very little about: (1) factors effecting male responsiveness to pheromone, (2) how to relate results of trapping to population density and to anticipated crop or commodity loss, (3) possible negative consequences of use of pheromonal traps.

The impact of factors like: population density, insect age, sexual deprivation, synchronization of pest development, weeds odour, field size and diversity of environment was discussed.

PRELIMINARY STUDIES ON CONTROLLING GRAPE CLEARWING MOTH Paranthrene regalis Butler BY MASS TRAPPING. Xian-han Tang, Shao-fu Xu, Jia-wei Du(Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China), Guang-lian Qian(Shanghai County Institute of Agricultural Sciences, Shang-hai 201109, China)

Grape clearwing moth, Paranthrene regalis Butler (Lepidoptera: Sesiidae) is an important pest of the grape vines in China. After hatching, the larvae bore into the stems in 20-120 minutes. So it is difficult to control using pesticides. The sex ratio of P. regalis is 1:1, and the male and female are monogamous, which are suitable for sex pheromone mass-trapping to control this pest. The field tests were carried out in two grape orchards (0.6 and 0.2 ha.) of Shanghai County, Shanghai in 1990. A total of 120 Pherocon 1C traps were placed in test plots at a rate of 150 traps per hactare. The traps were baited with rubber septa containing 500 ug of synthetic E3,Z13-18:OH. The results of mass-trapping trails showed a total of 243 males (in Plot 1) and 111 males (in Plot 2) were caught during 20 days and the grape vine infestations were only 1.49% and 1.95%, respectively. In comparison with the check plot (Plot 7), the percent reduction of grape twig damage in Plot 1 and Plot 2 were 95.6% and 94.3%, respectively. Compared with chemical control, the effeciency of mass-trapping is the same as that of spraying Sumithion two times (90.1% and 94.0% in Plot 3 and Plot 4, respectively), and better than that of spraying Sumithion one time (86.6% and 59.1% in Plot 5 and Plot 6, respectively).

APPLICATION OF SEX PHEROMONE OF THE SUGARCANE BORER IN CHINA. De-ming Wu (Institute of Zoology, Academia Sinica,Beijing, China)

The sugarcane borer is widely distributed in the South of China. This pest is usually controlled with chemical insecticides which lead to residue problems and environmental contamination. Field trials of controlling both the sugarcane stem borer, Chilo infuscatellus S. and the sugarcane striped borer, Chilo venosatus W. by using their synthetic sex pheromones showed that (a) the peaks of both egg laying and hatching of the sugarcane borer can be accurately predicted from trapping the male moths with rubber stopper dispensers. This method is better than others, and used in monitoring in about one and half million ha from 1983-1991; (b) Pheromone treatment by mass trapping and mating disruption with rubber stopper, rubber septa and polyethylene tube dispensers can reduce sugarcane borer damage at a low cost comparable to the standerd insecticides control programs. The direct control by phermone treatment has been used in about twenty thousand ha from 1984 to 1991.

FEMALE SEX PHEROMONES OF THE COTTON LEAF-ROLLER, *Notarcha derogata* (FAB.)(LEPIDOPTERA: PYRALIDAE) ON DIFFERENT PLANTS. Hiroshi Honda, Kei-ichi Himeno (Department of Agrobiology, The University of Tokyo, Tokyo 113, Japan)

The female sex pheromones of the cotton leaf-roller from the Chinese bottle tree, *Firmiana simplex* and the rosemallow, *Hibiscus mutabilis* were identified through chemical analyses and lab. and field bioassays. The pheromone gland extracts and virgin females from the two host plants had no cross-attractivity to the males from either host plant. (*E,Z*)-10,12-16:ALD and (*E,E*)-10,12-16:ALD were identified as major sex pheromone components of the females from the Chinese bottle tree. Binary blends of the two aldehydes in ratios of 6:4-7:3 were most attractive in blends tested. Each of the 4 geometrical isomers, however,was not attractive individually. In the females from the rosemallow, above two aldehydes were also found, while 9:1-10:0 blends of them were the best. (*E,Z*)-8,10-14:FOR, a mimic of (*E,Z*)-10,12-16:ALD, was attractactive to males when mixed with the (*E,E*)-10,12-16:ALD but the (*E,E*)-10,12-16:ALD was not interchangeable with (*E,E*)-8,10-14:FOR. Binary blends of these two mimics were not attractive to the male from both host plants.

STUDIES ON THE RELATIONSHIP BETWEEN THE DIFFERENT TERPENOIDS CONTENT OF PINE NEEDLES AND THE DEVELOPMENT OF THE PINE CATERPILLARS (Dendrolimus Punctatus Walker). Xiong Chen, Tao-qian Hou(Institute of Zoology, Academia Sinica, Beijing 100080, China)

The relationship between the different terpenoids content in pine needles and the development of pine caterpillars was investigated. Pine needles were collected from stands of pinus massoniana, pinus eliottii and pinus taeda in Anhui, Fujian and Henan Provinces. 19 kinds of terpenoids, including monoterpenes and sesquiterpenes were determined from the needles. There are some quantitative differences among the 19 kinds of terpenoids in three kinds of pine needles. Behaviour observations were made on first-stage larvae and newly emerged females of pine caterpillars. Insect feed preferences indicated that larvae preferred to feed on host-pine with low β-pinene contents. Female moths, however, didn't necessarily select those pines preferred by larvae for feeding, and tend to oviposite more frequently on pines with high β-pinene contents. But the pine caterpillars which feed on the needles with high β-pinene content will developed better than that with low β-pinene content, the larvae was heavier in weight, the pupae were bigger in size and the female moths were much more in pregnancy. The preference diversity of the larvae and the female moth of pine caterpillars will be very useful on the integrated control of this pest.

SPECIES-SPECIFIC PHEROMONAL COMMUNICATION IN WINTER GEOMETRIDS (LEPIDOPTERA: GEOMETRIDAE). G. Szőcs, M. Tóth (Plant Protection Institute, Budapest, Pf. 102, H-1525, Hungary), B. S. Hansson, C. Löfstedt (Department of Ecology, Lund University, Lund, S-223 62, Sweden), F. Schmidt, P. Philipp, W. Francke (Institute for Organic Chemistry, Hamburg 13, D-2000, FRG), K. Mori (The University of Tokyo, Department of Agricultural Chemistry Bunkyo-Ku, Tokyo 113, Japan)

Optimal, species-specific mixtures have been developed for attracting males of four geometrid species, members of the so-called winter geometrid complex, by field testing of various mixtures of components previously identified from the ovipositor of Erannis defoliaria and Colotois pennaria, as well as of related compounds. The importance of species-specific communication in maintaining reproductive isolation within the group of winter geometrids, where taxonomically related species adapted to similar ecological conditions, is discussed.

SEX PHEROMONE POLYMORPHISM OF SUMMER FRUIT TORTRIX MOTH *ADOXOPHYES ORANA* (LEPIDOPTERA: TORTRICIDAE) IN CHINA. Wen-jun Fu, Chang-ben Huang, Guo-ming Chen, Song-yun Wu(Shanghai Institute of Entomology, academic Sinica, Shanghai 200025, China)

The summer fruit tortrix *Adoxophyes orana* Fischer von Roslerstamm, is an important pest of fruit tree, tea and cotton in China. The sex pheromones of four strains of *A. orana* was investigated. The GC analytical results of volatile extracts of sex pheromone of female by airborn of single sex gland are different in ratio of two components, z-9 and z-11-tetradecen-1-ol acetate. The ratios of two isomers are respectively 24.83±6.24:75.17±6.24 from cotton field in Zhejiang;25.34 ±8.06:74.66±8.06 from tea plantation in Anhui; 79.00±8.27:21.00±8.27 from peach orchard in Beijing and 79.12±6.27:20.88±6.72 from apple orchard in Liaoning. The ratios of the strains in South China are different from the strains in North China. Traps in the field were baited with synthetic chemicals with different ratios of z-9 and z-11-teradencen-1-ol acetate. In North China, about 80% of males were attracted to the mixtures of 7:3 and 9:1 ratios. On the contrary, in South China,only about 10% of males were attracted to the above blends, but more than 60% of males were attracted to the ratios of 3:7 and 1:9. The result of field test was the same as the GC analytical. Thus the occurrence of sex pheromone polymorphism of *A. orana* in China was assumed.

SOME ASPECTS OF REPRODUCTIVE ISOLATION AMONG THE ORCHARD PESTS RECURVARIA LEUCTELLA AND R. NANELLA (LEPIDOPTERA: GELECHIIDAE). Miklós Tóth (Plant Protection Institute of the Hungarian Academy of Sciences, Pf 102, H-1525 Budapest, Hungary) and Robert E. Doolittle (USDA ARS, Insect Attractants, Behavior, and Basic Biology Research Laboratory, 1700 SW 23rd Drive, P.O.Box 14565, Gainesville Florida 32604, USA)

Male sex attractants have been defined through field screening tests conducted in Hungary for the white barred groundling moth, *Recurvaria leuctella* and the lesser bud moth, *R. nanella*, both orchard pests. The impact of the differences in chemical structure of the attractants and of some other factors on reproductive isolation among these *recurvaria* species is discussed.

MATING BEHAVIOUR OF MARUCA TESTULALIS GEYER (LEPIDOPTERA: PYRALIDAE). S.M. Waladde, W. Lwande and S.A. Ochieng' (International Centre of Insect Physiology and Ecology, P.O. Box 30772, Nairobi Kenya)

Studies were undertaken to investigate factors madiating the mating habits of the tropical legume pod bore Maruca testulalis, a serious pest of cowpae Vigna unguiculata walp. Mating occurs at night and maximum number of mating pair was seen 5-6h in scotophase. A stationary female assumes a calling posture by exposing her ovipositor. A male attracted by a calling female thumps her antennae with his protracted and expanded abdominal tip hair-pencils. The fast waving antennae are immobilized and held together by the fibre-like material from the hair-pencils. The male immediately turns around, makes genital contact and the pair remain in copula for 1-2h.

A crude extract from the hair-pencil material was detectable by the male and the female antennae in particular. However fractionation of that extract produced components which were not biologically active. On the other hand the crude extract from the ovipositor had two active component and one of them was specifically detectable by the male antennae. Work is in progress to establish the identity of the sex pheromone system in this pest.

Substrate specificity of the reductases involved in pheromone biosynthesis of *Ostrinia furnacalis* and *O. nubilalis*. Cheng-hua Zhao, Fang Lu (Institute of Zoology, Chinese Academy of Sciences, Beijing, China), Christer Löfstedt and Marie Bengtsson (Department of Animal Ecology, Lund University, Lund, Sweden)

A series of tetradecenoic acids, varying in position (from 7 to 13) and geometry of the double bond were topically applied to sex pheromone glands of *O. furnacalis*, and the E and Z strains of *O. nubilalis*. Deuterium-labelled fatty acids were used when the applied fatty acids were native pheromone precursors. Each application contained a fatty acid metabolic standard and the fatty acid to be tested in equal amounts. In *O. furnacalis* most of the fatty acids were converted to the corresponding acetates, but with very different relative conversion rates. However, in both strains of *O. nubilalis* only a few fatty acids could be converted to the corresponding acetates. In *O. furnacalis* the relative conversion rates of most E isomers were higher than those of corresponding Z isomers, except for the Δ11-tetradecenoic acids in which much more Z isomer was converted to the product. The relative conversion rate of labelled (*E*)-11-tetradecenoic acid was much higher than that of labelled (*Z*)-11-tetradecenoic acid in E strain of *O. nubilalis*, while the relative conversion rate of labelled (*Z*)-11-tetradecenoic acid was much higher than that of labelled (*E*)-11-tetradecenoic acid in Z strain. All of the present *in vivo* experiments indicate that the reductases in the pheromone biosynthesis of *O. furnacalis* and *O. nubilalis* have high substrate specificity, thus playing an important role for a given ratio of pheromonal geometric isomers to be produced in the two species.

SOURCE OF KAIROMONAL COMPONENTS FOR THE LEAF-CUTTING ANT. Afranio A. Craveiro, Fernando J. M. Sales (Federal University of Ceará, Caixa Postal, 12168 - 60451 Fortaleza, CE, Brazil)

The leaf-cutting ant, *Atta opaciceps* Borgmeier, 1939 (Hymenoptera:Formicidae) is a common fungivorous species of the Brazilian northeast ecosystems with a known record of exotic, native and cultivated plants used as substrate to its fungus. Soil from the mounds nest is a powerful fertilizer which has been used in enhancing productivity in cassava, corn, cotton and soybean. The insect usefulness has changed research efforts toward behaviour control and in a later step, domestication. Ássays carried out at the Federal University of Ceará, Brazil have disclosed that *Senna siamaea*(Lam.) is a source of allelochemicals. Flowers collected from field trees were examined in a stereoscope to remove any source of physical and biological contamination. The sample was weighted and transferred to a glass extractor with an end connected to a small entrainment filter and the other extreme linked to an air filter. Both filters were packed with activated charcoal. The system was fastened to a pump which forced a gentle stream of filtered air pass through the flowers for 48 hours with laboratory temperature at 22±1°C and 61±5% RH. The active extract from the entrainment filter was removed with dichloromethane. A 10ul aliquot of a 120ug $e.ul^{-1}$ solution was injected in a SE-54, fused silica capillary column, 30mX0,25mm, 0,25um id, programmed at 50-180°C/4°C/min then 180-250°C/20°C/min, of a GLC-MS computer assisted system. The mass spectral data indicated acetic butyl ester; 2-methyl, 2,4-pentanediol; n-decane; n-undecane; n-dodecane; n-tridecane as the major kairomonal components.

THE SEARCHING BEHAVIOUR OF A PARASITIC NEMATODE, STEINERNEMA FELTIAE AGRIOTOS, TO LARVAE OF THE ASIAN CORN BORER OSTRINIA FURNACALIS (GUENEE). Kang-lai He, Da-rong Zhou (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

The movement and orientation of the juveniles of a parasitic nematode Steinernema feltiae Agriotos(JSFA) towards one of its hosts-the larvae of Asian corn borer Ostrinia furnacalis (Guenée), were observed under laboratory conditions. The JSFA, when placed on a sheet of moistened filter paper, can move to a distance of 12cm away from the original site of inoculation, either with (48hrs) or without (96hrs) host in that direction. However, the speed of movement would be faster and the number of JSFA would be more in case that it was with the host. This phenomena may indicate that the JSFA actually performed a searching behaviour towards its host. Furthermore, it was observed that the JSFA can move upward provided that the sheet of filter paper was held in a vertical position.

HOST STAGE SELECTION OF THE SPHERICAL MEALYBUG (HOMOPTORA: PSEUDOCOCCIDAE) BY ANAGYRUS SAWADAI ISHII (HYMENOPTERA: ENCYRTIDAE). Tsong-Hong Su,(Department of Entomology, National Chung Hsing University, Taichung, Taiwan, China)

A native encyrtid parasitoid, Anagyrus sawadai Ishii, a native coccinellid Scymnus (Nephus) ryguus Kamiya, and an introduced ladybird beetle, Cryptolaemus montrouzieri (Mulsant) were found to be natural enemies of the spherical mealybug, Nipaecoccus vastator (Maskell), in Taiwan. To gain a better understanding of the parasitoid/host interaction between A. sawadai and N. vastator, we conducted various aspects of the parasitoids host stage selection behavior. All four of the tested spherical mealybug stages were susceptible to parasitism by A. sawadai when each stage was exposed separately. Parasitoid females that were offered a choice of all four spherical mealybug stages, oviposited only in third nymphal and adult female hosts. A. sawadai was able to complete development and emerge following parasitism of second, and third nymphal stage and adult female host stage, but parasitoid development was the fastest, the number of parasitoids emerging and the ratio of female to male parasitoid was the highest following oviposition in third nymphal and adult female host. The results have values for implications in mass-rearing of A. sawadai for biological control.

COMPARATIVE STUDY ON NESTMATE RECOGNITION OF WORKERS AND THEIR HYDROCARBON PROFILES IN THE JAPANESE, THE ASIAN AND THE EUROPEAN HONEYBEE. H. Sasagawa*, Y. Kizawa and Y. Kuwahara (Institute of Applied Biochemistry, University of Tsukuba, Tsukuba Ibaraki 305, JAPAN) *:Department of Environmental Toxicology, Toxic Substances research and Teaching Program, University of California-Davis, Davis CA 95616, U.S.A.

The same habitat was shared by the Japanese honeybee, Apis cerena japonica Rad (Acj) and the European, A. mellifera L (Am) in Japan. Both workers were experimentally introduced to their own hive, to the other conspecific hive, and to a hive of the other species as well. Am hives accepted 52% per trials of day-0 Am workers and 85-88% of Acj foragers. On the other hand, Acj hives accepted almost all foragers of the other hive (96% average) and day-0 Am workers as well (90%). Accidentally damaged hivemates as well as non-hivemates during experiments were rejected, even in the friendly Acj. As a result, nestmate recognition in Acj among different colonies and against different species were milder than those of Am.

Hydrocarbons were analyzed by a GLC and a GC/MS, and were compared among three species, using waxes and body surface extracts derived from workers and drones. Each species were distinguishable not only combination of components, but also occurrences of specific components to a species. Acj workers contained C_{23}(16.7%), C_{25}(38.7%), and C_{27}(30.0%), and these of Am workers C_{25}(12.3%), C_{27}(25.2%), C_{29}(14.2%), C_{31}(16.4%) and C_{33}(18.3%) with various degree of unsaturation (0 to 3). Alka-6,9-dienes (C_{25} to C_{29}) was present in Acj, while Am possessed dienes with $(CH_2)_n$ (n>3) between double bonds.

Hydrocarbon profiles among individual workers and drones of a hive were noticed to be different in Acj, Am and the Asian bee as well. These from drones were devided into 2 groups, whereas those of workers into 5 to 10 groups, depending possibly on queen's multiple mating during her nuptial flight.

CASTES IN BELONOGASTER: RUDIMENTARY OR DISTINCT? Malcolm G. Keeping (Zoology Department, University of Durban-Westville, P/Bag X54001, Durban 4000, South Africa)

Established colonies of the paper wasp Belonogaster petiolata displayed a well-developed reproductive division of labour between foundress queens and worker offspring. Workers were socially subordinate, foraged frequently, and were short-lived. In normal queen-right colonies, workers were permanently sterile (never laid eggs); they also had poorly developed or undeveloped ovaries, were uninseminated and significantly smaller than foundresses, and contained significantly less fat. Workers were produced regularly during the early part of the pre-emergence stage. Established queens were socially and reproductively dominant, very seldom or never foraged, and were long-lived; they had well-developed ovaries, were inseminated, and contained substantial fat reserves. I argue that in most Belonogaster species studied to date, social and reproductive dominance is sufficient to produce a regularly occurring sterile worker caste and that these species have, therefore, reached the "highly social" stage in West-Eberhard's (1978) hypothetical scenario for the evolution of sociality in the vespid wasps.

MANIPULATION OF THE LEAF-CUTTING ANTS THROUGH THE USE OF ALLELOCHEMICALS. II. STIMULUS AND BEHAVIOUR PATTERNS. Fernando J. M. Sales, Philip E. Howse (Federal University of Ceará, Caixa Postal,12168 - 60451 Fortaleza, CE, Brazil and The University of Southampton, Building 44, Southampton SO9 5NH, England)

The American multicomponent ecosystems shelter 18 species of the leaf-cutting ants. Myrmecologists have acknowledged Brazil as the center of origin of this taxon where they have been dwelling for nearly 30 millions years. This country houses 12 species of this formicid and *Atta sexdens rubropilosa* Forel, 1908 (Hymenoptera:Formicidae) is abundant in the Brazilian southeast, central and southwest regions. Allelochemicals extracted from plants have given promising results in behavioural manipulation. Experiments accomplished at The University of Southampton, England, have indicated that flowers of *Mahonia aquifolium* lodge potent kairomonal components. Experimental data were transferred to a 16-bit X-TEC microcomputer, MS-DOS v. 4.0, Statgraphics v. 2.1, connected to a 180cps matricial printer. Sterilized anti-bumping granules treated with 15ug*e* of kairomonal extract induced the ants to transport 98,16% of the material to the nest. When the stimulus source is introduced on the foraging table, the workers react in the following patterns: a) They turn around and return to the fungus gardens, occasionally touching the tip of the abdomen on the trail surface, then recruit the nest mates; b) they stop, raise the antennae, assess the environment and move straight to the selected treatment; c) they move immediately to the chosen treatment, and d) after the first contact, they take the granules to the nest. Supernormality and chain transport were observed.

MECHANICAL AND SALIVARY EFFECTS OF POTATO LEAFHOPPER FEEDING IN RELATION TO HOPPERBURN IN ALFALFA. Carol Ecale and Elaine Backus (Department of Entomology, University of Missouri, Columbia, MO 65211 USA).

The potato leafhopper (PLH), *Empoasca fabae*, causes hopperburn in alfalfa by direct feeding damage. Previous work has shown that feeding by the PLH on alfalfa stems results in proliferative growth of cambial tissue. The exact mechanism of hopperburn development is unknown; however, it is postulated that a combination of mechanical and salivary factors may be linked to physiological changes in plant tissue leading to abnormal cellular changes within vascular bundles. Attempts were made to separate the mechanical and salivary aspects of PLH feeding. An implantation bioassay failed to detect salivary factors involved in hopperburn initiation. Simulation of mechanical feeding damage was performed by impaling stems with rigid implements approximating the size and shape of PLH stylets. Cellular changes which resemble PLH feeding damage were observed with mechanical damage in the absence of salivary factors. This evidence implies that the cellular changes associated with hopperburn initiation may be explainable by mechanical damage inflicted during PLH feeding and that salivary factors are not required. Work is ongoing to determine whether plant vascular tissue is repaired over time following PLH feeding damage.

EVOLUTION AND MATERNAL BEHAVIOUR IN EARWIGS

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The Dermaptera present several morphological characteristics: special wings, pincers, etc. So is their maternal behaviour which seems to exist in every species of the order. This anatomical and behavioural homogeneity makes possible the group to be monophyletic and the maternal behaviour to have emerged once only.

This behaviour is organized in two phases: During the first the female care for her eggs and hatches out her young. Without the female the eggs abort before hatching.

The function and the duration of the second phase, during which the larvae and the female stay together in the burrow, differ from one species and even from one population to another.

Several inter- or intra-specific differences are described in *Labidura riparia*, *Forficula auricularia* and *Anechura bipunctata*.

BROOD RAIDING AND SURVIVAL OF INCIPIENT COLONIES OF THE FIRE ANT *SOLENOPSIS INVICTA*.

W. R. Tschinkel (Department of Biological Sciences, Florida State University, Tallahassee, FL 32306, USA)

Incipient colonies of the fire ant engage in reciprocal brood stealing with other incipient nests . Nests beginning with more minim workers tend to win these contests, and workers from the losing nest usually join the winner. Losing queens often abandon their nests and try to enter other incipient colonies where they sometimes succeed in becoming the young colony's queen mother. Brood raiding is a major cause of incipient colony mortality. In field experiments, over 60%of the observed mortality of incipient colonies could be accounted for through brood raiding. As colonies grow through winning raids, they raid longer, more and farther. At a scale of up to tens of meters, the effect of raiding is to aggregate most incipient colonies into a small number of nests, hastening early colony thinning and boosting colony size and growth.

FUNCTION(S) OF MATERNAL BEHAVIOUR IN *FORFICULA AURICULARIA*

Z.B. LIU[1&2], [1]Laboratoire d'Ethologie, CNRS UA 373, Université de Rennes I, 35042 Rennes cedex, France, [2]Laboratory of Entomology, Institute of Zoology, Shaanxi Normal University, 710062 Xi'an Shaansi, China.

The maternal care exhibited by *Forficula auricularia* take place in a nest burrowed by the female.

The intensity of different types of contacts between the female and her young, particularly the "mouth to mouth" contacts, depends on the respective feeding condition of the animals.

Larvae deprived of food but in contact with a normally fed female increase their weight and their survival.

The maternal care may have other function(s). By attracting the larvae to her burrow for the daytime, the female has presumably also a role of physical protection and, as she is aggressive, a role of defence against predators.

STUDIES ON HOST-SELECTION BEHAVIORS OF *TRICHOGRAMMA DENDROLIMI*.

Hong-gui Qiu, Zhong-liang Qiu, Wen-jun Fu, Ming Zhou, Bo-jun Shen, Guang-hua Liu (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China)

Olfactory experiments showed that *T.dendrolimi* from eggs of *Dendrolimus punctatus* respond significantly on its odour when treated with needles of *Pinus massoniana*. The difference between number of females in the area of odour and that of the blank is highly significant, $p<0.01$. However, the behavioral response of *T.dendrolimi* collected from sugarcane fields on the odour of *Pinus massoniana* have not obvious difference as compared with blank. Behavioral responses of both strains of *T.dendrolimi* to the odour of the corn leaves is obvious, but is not obvious to the odour of *Canna generalis*. Experiments showed that plant odour play an important role in host-habitat location of *T.dendrolimi*. Parasitical behavior of female wasps are closely related to host distribution. When single female parasitized clustered host egg, the number of average progeny per parasitized egg are less than that of singularly-distributed host egg. But the number of parasitized host eggs increased with the size of eggs clustered. Experiments showed that the response of female to clustered host eggs decreased with the progeny allocation per parasitized egg, and increased with the number of parasitized host egg.

#1

OVIPOSITION BEHAVIOUR OF *PRIONOMITUS MITRATUS* DALM. (HYM. ENCYRTIDAE) ON PEAR *PSYLLA PYRI* L.(HOM.: PSYLLIDAE). Assadollah Aghamirkarimi (P.O. Box 11365/7117, Aboureyhan Tehran-Iran)

In this investigation, it was found that the parasitoid was attracted first by host plant kairomon from distant, when she closed will be attracted by host insect. The parasitoid recognises healthy hosts by her antennae, paralizes it by stinging, and needs to feed from host body fluid before oviposition.

The oviposition spot is located by tarsi and the eggs are inserted in the body singly and most of the cases underneath the wing pael. Ontogeny of parasitoid in the host body and the behaviour of parasitized insect will be discussed.

#2

LEARNING AND PREY PREFERENCE IN THE PREDATORY BUG, Eocanthecona furcellata. Mitsutaka Sakakibara (National Institute of Sericultural and Entomological Science, Tsukuba, Ibaraki 305, Japan).

A pentatomid bug, Eocanthecona furcellata is known as an effective predator of many insect pests in the Oriental region. The prey preference of E. furcellata was checked by the choice test. Newly emerged adults prefered the prey at the nymphal stadia. As adults grew older, adults fed more prey species. The adults that fed the rice armyworm (Pseudoletia separata) larvae at the nymphal stadia became to feed the pellucid zygaenid (Pryeria sinica) larvae, promptly.. However, the adults that fed P. sinica larvae at the nymphal stadia did not prefer P. separata larvae easily. When these adults were allowed to feed only P. separata larvae, the adults became to prefer P. separata larvae again. After all, learning was concerned in the prey preference in E. furcellata. Larval development of E. furcallata differed with the prey species. Nymphs that fed P. sinica larvae grew faster and larger, and showed lower mortality, than nymphs that fed P. separata larvae. Hence, the prey preference of E. furcellata also seems to coincide with the host suitability.

#3

BEHAVIOR AND NESTING PARASITISM *EVAGETES PESTINIPES* (LINNAEUS) (HYMENOPTERA; POMPILIDAE). Alexandr S. Voblenko (Institute of Zoology Ukrainian AS, Kiev, 252601, Lenin St., 15. Ukraine)

Evagetes pestinipes is one of the commonest pompilids on the South of Ukraine. Knowledge of the nesting behavior and prey preference of *E. pestinipes* is based on isolated observations of individual females. This species is cleptoparasites of other Pompilidae, among their number *Batozonellus lacerticida* Pallas and *Episyron rufipes* (Linnaeus). The female excavated down to the cell of the host pompilid where she consumes the host egg and substitutes her own. The penetration on the host nest and development of larva has been studied in detail.

#4

ADAPTABILITY OF Trichogramma papilionis Nag. TO Ostrinia furnacalis Guenee EGG MASS. M.Y. Hussein, M. Schilthuizen and Z. B. Ahmad (Plant Protection Department, Universiti Pertanian Malaysia, 43400 Serdang, Selangor, MALAYSIA).

Ostrinia furnacalis Guenee (Lepidoptera : Pyralidae), a major insect pest of maize throughout Malaysia, is attacked by a larval, a pupal and a new egg parasitoid (Trichogramma papilionis Nag). Laboratory and field rate of egg parasitization is almost 100%. High level of parasitization rate was attributed to the host searching and oviposition behaviour of the female parasitoid. A type III functional response was obtained, caused by a tendency of the females to remain inactive at low host densities. The parasitoid seems to be well adapted to parasitizing the host eggs presented in masses. At the leaf level, the parasitoid first fully parasitize a section of the host egg mass before resuming its search and oviposit on the rest of the eggs. This can be viewed as an adaptation to a host that produces eggs in masses instead of single eggs. The role of kairomone and plant odours in the host searching process are now being investigated.

#5

STUDIES ON THE SEX PHEROMONE OF POPLAR BOLE CLEARWING MOTH, SESIA SININGENSIS(HSU) . Zhenyu Li, Peiheng Wu (Forest Resources College, Beijing Forestry University. Beijing 100083, China) Guangzhong Guo (Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences)

It has been proved that Z3, Z13-18 OH-Octadecadien-1-01 la is the sex pheromone of Sesia siningensis(Hsu). The sex pheromone can be used for predicting the emergence duration and emergence size of the moth population, and for the controlling of the pest. Through a mass-trapping experiment with the sex pheromone in poplar forests, it has been found that the mating rate of female moth decreased 28. 1-95. 6% , averaging 42.8% -47.6% , and the population density decreased by 38.2% after 3 years of continuous mass-trapping.

#6

RELEASE RATES OF INSECT PROPHEROMONE COMPONENTS AND FIELD ATTRACTIVENESS OF PROPHEROMONES. Xun Liu, Xiao-Qing You. Jie Kong. Zhong-ning Zhang, Zhao-Xiang Lo and Yu-Chen Chen. (Institute of Zoology . Academia Sinica. Beijing 100080. China)

Release rates of sex pheromone components (Z) -11-hexa-decenal and (Z) -9-hexadecenal from natural rubber septa impregnated respectively with above aldehydes and their photosensitive acetals—(Z) -1. 1 -di-o-nitrobenzoxy-hexadec-11-ene and (Z)-1. 1-di-o-nitrobezoxy-hexadec -9-ene were determined by means of glass surface aborption method under irradiation of simulated sunlight. Experimental results showed that as the ageing time pro-longed the decreasing tendency of release rates of photosensitive acetals was slower than that of corresponding aldehydes. The attractiveness of propheromonal lures to Heliothis armigera, Chilo supprasalis and Mythimna separata was more potent than that of pheromonal lures at the late stage in the whole catch period. A release mechanism of propheromone from natural rubber septa was proposed.

#7

USE OF SYNTHETIC INSECT SEX PHEROMONES FOR CONTROL OF SOME IMPORTANT INSECTS IN TAIWAN. Chi-Chu Lo, **Jenn-Shen Hwang** (Taiwan Agricultural Chemicals and Toxic Substances Research Institute, 189, Chung Cheng Road, Wufeng, Taichung Hsien, Taiwan, China), **Shin-Chwan Lee** (Kaoshiung District Agricultural Improvement Station, Taiwan, China), **Fu-Cheng Yen** (Tainan District Agricultural Improvement Station, Taiwan, China), **Cheng-Jiung Liu** (Tao-Yuan District Agricultural Improvement Station, Taiwan, China)

The strategy for pest control in Taiwan is directed less on kill, and more on control. In 1985, the Council of Agriculture decided to use insect sex pheromone as part of an integrated pest management program. Results of studies of the improved synthetic methods and the field tests from 1985 to 1991 are briefly discussed.

Key words-Synthesis, formulation, purity, quality control, field tests. *Eucosma notanthes* Meyrick, *Cryptophlebia ombrodelta* Lower, *Spodoptera litura* (F.), *Ostrinia furancalis* (Guen'ee), *Cylas formicarius elegantulus* (Summers), *Cylas formicarius formicarius* (F.).

#8

ANALYSIS OF SOME BEHAVIORAL CHARACTERISTICS OF THE MALE MOTHS OF PHYLLOCNISTIS CITRELLA STAINTON IN JAPAN USING SYNTHETIC SEX ATTRACTANT TRAPS. Takeshi Ujiye (Okitsu Branch, Fruit Tree Research Station, Okitsu, Shizuoka 424-02, Japan)

Ando et al. (1985) observed that (Z,Z)-7,11-hexadecadienal powerfully attracted the male moths of the citrus leafminer, P. citrella. Using traps baited with 1 mg of the material, the attractant-mediated behavior of male moths was studied in citrus groves and woods in the Kuchinotsu area, in the northwestern part of Kyushu, from 1984 to 1988. Males were caught not only in traps placed in the groves, but also in those placed in other trees located 200m or more from the nearest citrus grove, thus they seemed to move at least 200m in their activity. During the first flight period of late May to early June, the traps placed in the groves caught a considerable number of male moths, in spite of the low larval population density previously annually recorded there. This suggested that moths moving from outside the groves were an important component of the catches. Comparison between daily catch counts and prevailing weather conditions suggested that the lowest threshold temperature at which flight occurred was about 9°C, and that active flight took place when wind velocity did not exceed 2.0 m/sec.. The presence of rainfall without wind did not appreciably affect the trap catches.

#9

STUDIES ON STABILITY, VOLATILITY AND FIELD PERFORMANCE OF APHID ALARM PHEROMONE–(E)- β - FARNESENE. Zhong-ning Zhang, **Xun Liu, Xue-qin Mei**(Institute of Zoology, Academia Sinica, Beijing 100080, China), **Zhi-bin Li, Xiou-guang Chen, Xu Zhai** (Datong Plant Protect Station, Shanxi, China),**Xiao-yun Meng, Yong-cheng Pan** (Shuang-qiao Farm, Beijing, China), **Jin-xia Zhao. Wen-xiou Li** (South-suburb Farm, Beijing, China)

(E)-β-farnesene (EBF, sesquiterpene) is the main component of alarm pheromone of many aphid species. EBF is very volatile: in dry and room temperature condition 300ul solution EBF in hexane: 1ul/ml in filter paper (diameter 1cm) EBF evaporated completely in 2hrs as monitored by GC. EBF is stable by air (room temperature), heat (40°C) and light (room temperature, nitrogen protect, 8w fluorescent); the half-lifes are: 20 days, 31 days and 12 days, respectively. After 1 year stored with commercial insecticide sumicidine (20% Fevelarate) in normal condition, 80.9% of the EBF (1% in sumicidine) still remained.

The mixture of EBF and insecticide (sumicidine) can be used in field to control aphids. The alarm pheromone can increase the effectiveness of contact insecticides. The result (in 100 ha for two years) showed that: (1) when using EBF (0.1-1%) with sumicidine (content 20% fevelarate), the dose of sumicidine can be reduced to 50%; (2) As using the mixture of EBF and sumicidine in the concentration 0.033%, 0.02% and Kungfu (Grenade) 0.033%, the yield of Chinese cabbage would increase more than 23%.

#10

MASS REARING METHOD OF THE CARAMBOLA FRUIT BORER, *EUCOSMA NOTANTHES* MEYRICK. Chau-Chin Hung and Jenn-Sheng Hwang (Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Wufeng, Taichung, Taiwan 41301, China).

A mass rearing method was developed for the carambola fruit borer (CFB), *Eucosma notanthes* Meyrick. Two artificial diets, with sweet corn and carambola powder, respectively, as the main ingredient were tested. The corn diet gave better development and fecundity, and was successfully used to rear CFB for more than 30 generations. The developmental period of egg, larva and pupa on the corn diet at 25±2°C were 5.9, 18.4 and 9.9 days, respectively. The longevity of adult females and males were 17.4 and 14.9 days, respectively. Fecundity was 127 eggs/female. Based on the results of studying mass rearing method, the following mass-rearing procedures are suggested for CFB: Adults are first transferred to air-enriched plastic bags and given 5% honey water. After eggs are laid on walls of the plastic bags, the bags are renewed every 1 or 2 days. Eggs are cut off from the bags. Depending on the black-head stage of eggs, eggs are incubated at different temperatures. The mass of eggs at the black-head stage are inoculated on artificial diet of rearing container. After 10 days, corrugated cardboard strips are put in the rearing container for pupation. Fifteen days later, the pupae are collected from the cardboard strips for experimental use or further reproduction.

#11

MATING BEHAVIOUR AND SEX PHEROMONE OF PERILLA LEAF PYRALID MOTH, *PYRAUSTA PANOPEALIS* WALKER (LEPIDOPTERA: PYRALIDAE). Kwang Youl Seol (Sericultural Experiment Station, RDA, Suwon, Korea), Seok Ku Kang (Department of Chemistry, Sung Kyun Kwan University , Suwon, Korea)

To establish the successive rearing method of the perilla leaf pyralid, *Pyrausta panopealis* Walker, experiments were carried out with three diets based on a JAMSI-type artificial diet for silkworm. On the SS4 diet containing 40% of perilla leaf powder the pupal and adult yields were higher than those on the fresh green perilla leaves.

The calling and mating behaviour of the pest insect were observed. The emergence of most males and females took place during light period, showing a different emergence pattern from the pattern of nocturnal insect and the receptive female exhibited a stereotyped calling posture by extruding and bending the abdominal tip towards the dorsal surface.

The males did not show any stereotyped mating dance when the females began calling. The attraction of males to the females was therefore used as a criterion for the sex pheromone bioassay. In the laboratory bioassay, the males strongly responded and were attracted to virgin females or the abdominal tip extract of virgin females.

Now the entire components of the sex pheromone are under identification.

#12

A COMPARISON OF THE PERFORMANCE OF THREE DIFFERENT DIETS USED IN THE CULTURE OF CHIRONOMUS COSTATUS Leng-Hong Teo, Ti-Wen Chen (Department of Zoology, National University of Singapore, Kent Ridge, Singapore 0511)

Three different diets, namely wheat bran, rice bran and soya bean refuse were used as diets in the culture of bloodworm (larvae of Chironomus costatus) in glass tanks of the following dimensions: 54 x 90 x 45 cm. Water level was kept at 20 cm. The performance of these three different diets was compared by looking at the body sizes of the imagoes developed from larvae fed on them, the survival rates of the larvae, the time taken for the larvae to develop into imagoes and the fecundity of these imagoes. Larvae fed on soya bean refuse had the highest survival rate, developed into biggest adults, and produced the largest number of eggs at the stocking densities of 2000 and 3000 eggs per tank but slightly less eggs at the stocking density of 4000 eggs per tank . Larvae fed on rice bran developed faster than those fed on other diets.

#13

STUDIES ON THE MASS REARING OF CORN BORER: II. IDENTIFICATION AND CONTROL OF A BACTERIAL DISEASE IN AN ASIAN CORN BORER OSTRINIA FURNACALIS (GUENEE) MASS-REARING PROGRAMME. Rui-yun Wei, Li-ping Wen, Shu-min Zhu, Da-rong Zhou (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094 China)Shu-liang Feng, Xiu-hua Fan(Institute of Plant Protection Hebei Academy of Agricultural & Forestry Sciences, Baoding 071000 China)

A very destructive bacterial disease was found in an Asian corn borer Ostrinia furnacalis (Guenée)(ACB) mass-rearing programme. According to morphological studies, staining reactions and serological characteristies, the pathogen was identified as Bacillus thuringiensis var. kurstaki, serotype H_{3a3b}. In searching for effective controlling measures, the following treatments have been proved to be very promising:a) putting the rearing containers into a tightly sealed wooden box and fumigated with a mixture of 36% formalin and potassium permanganate at a sosage of 80ml and 60g per cubic metre, respectlvely, under the conditions of 20 to 30°C and 70 to 80% R.H. for 24hrs; b) sterilizing black-headed ACB egg-masses with 4% formalin under 28°C for 30 min.; and c) incorporating ergthromycin into the semi-artificial diet with a concentration of 100ppm. No detrimental effects were found in the growth, development and fecundity of the insect after such treatments.

#14

BREEDING FOR A SENSITIVE LINE OF COTTON BOLLWORM AND REARED FOR SUCCESSIVE GENERATIONS. Yong-qiao Zhao, Xian-lin Fan, Cen Wei (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094,China)

In June of 1984, we collected 30 pairs of adults and 334 larvae of the cotton bollworm Heliothis armigera Hübner, from different fields in Hebei and Henan Provinces. They were paired and reared with semi-artificial diet for successive generations under suitable laboratory conditions without any contact of chemical insecticides. Healthy and strong individuals were selected continously from each generation to get rid of diseased and inactive insects to obtain a purified laboratory culture. Until now, it has been reared for seven years and two months without breaking or stopping the rearing and is in its 94th generation. To measure the sensitivity of this advanced-generation culture to three different types of insecticides, its LD_{50} value, as compared with those in Chinese or foreign literatures, is the lowest. The authors considered this laboratory culture as a purified, stable, sensitive line, which is of theorectical and practical significance in the studies of resistance monitoring, forecasting and manipulations to this insect species.

#15

DIRECT PHEROMONE CONTROL ON Zeuzera pyrina L.(Lep_Cossidae) ON WALNUT TREES IN ENJEDAN,ARAK,CENTRAL PROVINCE ,IRAN , S.A.SADJADI , M.ESMAILI (Department of plant protection,Agricultural College_Tehran university,Karadj,IRAN

In orther to study effect of direct pheromone control against(Zeuzera pyrina L.) and population control this pest was performed in sake of leopard moth damage 100% to walnut orchards in Enjedan of arak district and being unapplied ofother control metods in years of 1989-1991.Two isolate orchards in 1 and 1.5hectar with 296trees 4 upto10 years,indistance of3-8 meters,with pheromonetraps in kind ofcupbord which they have traptest indistance of 50 meters which attracted 798 male insects in1990 and 67 male insect in 1991.In sep.1989 the quantities of larvy active canales 13.3 in each tree in dec.1990to1.7and in dec1991 to 3% decresed.And also in 2 orchards were studied as witness with 4 pheromonetrap and 4 traps with virgin female and 1 light trap in on orchard without interfer of numbers of active canals was incresed from14.5 peices inSep.89 in each tree and to16 peices in Dec.90 and to17,3inDec.91 As basic control pheromone capsula(Synantedon tipuliformis) contins of material (E.Z.,2,13-18acetate)was used.With sampling third a week,was determined appearance Peak and decres(Z.p)and its relative with($\overline{Tem}$&$\overline{HR}$%)area.In this area(Z.p)monovoltin with 2-4 days of period oviparous and behaviour biogamy was absorved.
appearance ofadult insects was from 15/5to20/6 in1990and peak 26/5 ($\overline{Tem}$=22.5-24°c) and was from 29/5to5/7in1991and was peak in17/6($\overline{Tem}$=22.5-23°c). Flight of insects was from21 till 23 and peak of flight at 22 0,clock.
Incunclosion the attractive role of pheromone(Synantedon tipuliformis)has operated as and effect control in mentioned conditions against (Z.p) and an applied method will be used in surface of walnut orchard.

#16

MULTIPLE MATING IN THE TORTRICID, CHORISTONEURA ROSACEANA. **J. Delisle and A. Bouchard.** Forestry Canada. P.O. BOX 3800, 1055 PEPS, Sainte-Foy, (Quebec). Canada. G1V 4C7.

It has been suggested that multiple matings in female Lepidoptera occur to compensate for an inadequate sperm supply received at first mating and/or as a result of sperm depletion. Using C. rosaceana females mated after 1, 3, 6, and 9 days, we demonstrated that the proportion of females that attracted males, as well as the mean number of males attracted, increased with the time elapsed since mating. Mated females attracting males in the field were significantly less fecund and laid fewer fertile eggs than non-attractive females. A similar trend was noted when the titer of pheromone was quantified in laboratory-reared females at different times following mating. Furthermore, the incidence of remating was significantly higher in older than younger females. This suggests that early remating may be due to the poor quality of the first male, while in older females it is a combination of sperm quality and sperm depletion. Spermatophore size decreases significantly after the first mating yet under field conditions, >90% of all tethered virgin females received large spermatophores at mating. While larval food did not affect the size of the first spermatophore produced by the male, it has a strong influence on male quality as measured by the number of fertilised eggs produced by females mated with males reared on different host plants. This suggests that incidence of multiple mating observed in several populations of C. rosaceana may be due, at least in part, to spermatophore quality.

#17

STRUCTURAL AFFINITY BETWEEN SEX ATTRACTANTS AND THEIR INHIBITORS IN LEPIDOPTERA. I.Ya. Grichanov (Institute for Plant Protection, St.-Petersburgh, Russia).

65 chemicals known as inhibitors of sex attractants were studied for affinity with main components of sex pheromones in 95 lepidopteran species, mostly tortricid and noctuid moths. Based on the list of inhibitors of sex attractants, about 200 "sex attractant main component vs. sex attractant inhibitor" pairs were found (i.e. about 2 antipheromones per species). The structural affinity between sex attractants and attractant inhibitors was analyzed statistically, using the chemical classes that had the largest number of pheromone. When the sex attractant classes were compared with their respective inhibitor classes for each species, it was found that for the most part Z-isomeric attractants were inhibited by Z-isomeric chemicals (76%), acetates by acetates (69), and 12-, 14-, and 16-C-atom attractants respectively. The next step was to determine how great were the differences between sex attractants and their inhibitors. The analyses of pairs of sex attractants and their inhibitors for each species showed that "one change" relationship (Steck et al, 1982) was most frequent (72%) both in pheromones of Lepidoptera as a whole and in separate families. Most often attractants differed from their respective inhibitors in type of the functional group (I type). Differences in Z/E-isomery (II), double bond position (III) and number of biochemical changes during biosynthesis (IV) were also not infrequent. Comparing these frequency differences in tortricid and noctuid moths, we can notice that I, II, III type differences most often occur in tortricids, I and IV type differences in noctuids. These findings show that the known antipheromones are very close in chemical structure to sex attractants.

#18

Behaviour of male Grapholita molesta in overlapping pheromone plumes in a wind tunnel.

Valeur, Peter and Löfstedt, Christer. Lund University, Department of Ecology, Helgonavägen 5, S-223 62 LUND, Sweden.

The behaviour of male *Grapholita molesta* in overlapping pheromone plumes was studied in a laboratory wind tunnel. Two baits were placed either after or next to one another in the wind tunnel, making the plumes overlap as much as possible.We used baits with synthetic blends and baits with female extracts. We varied the total load of pheromone and we varied the number of active components added to the baits and observed the number of males responding to the different sources.The complete blend disrupted the response to a second bait more than incomplete blends did. Overshooting to the distant (from the males point of view) bait was small. Even with a 30 µg bait lying next to or in front of a 0.3 µg bait the response to the weaker bait still was remarkably high (>15%). The results demonstrates the high ability of *Grapholita molesta* male moths to discriminate between different pheromone blends. The males notice the presence of a correct pheromone source even when the plume is mixed with various incomplete blends. The results are discussed in the context of mating disruption.

#19

STUDY OF SEX PHEROMONE OF COTTON BOLLWORM, HELIOTHIS ARMIGERA HUBNER. Shi-zhen,Ren, Shan-gan Zhang (Institute of Zoology, Academia Sinica, Beijing 100080, China), Te-ming Chen, Department of Biology, Peking University, Beijing 100871, China).

As being one of the most important pest of cotton, corn, tomato and other crops in our country, the cotton bollworm, Heliothis armigera Hubner (Lepidoptera,Noctuidae) is a polyphagous insect which widely spreads throughout the world. This paper briefly reports the research results about the sex pheromone of cotton bollworm. Sex pheromone glands were studied under LM and SEM to locate the exact position. Generally, they are found in the intersegmental membrane between the 8th and 9th abdominal segments as in most lepidoptera. During calling, the virgin female in the cage released their sex pheromone with their evipositors extended and wings stretched out adhering to tne leaves of their host. The virgin female assumed the calling posture customarily in the mid night 01:00-05:30 AM and reached its maximum around 02:00-04:30 AM. According the analysis of GC,GC/MS EAG and field experiment with synthetic samples, we conclude that sex pheromone major component is Z11-hexadecenal and minor components are Z9-hexadecenal and Z7-hexadecenal. We have found three blends which could catch male more than the attraction of the virgin female and a bunch of poplar by field screen experiments. According to our results of monitoring surveying in the most important cotton areas in our country, we propose four criteria to guide pesticide spraying on cotton bollworm pest control.

#20

ELECTROANTENNOGRAM COMPARISON OF SEMIOTHISA CINEREARIA ELICITED BY SYNTHETIC AND NATURAL SEX PHEROMONE. Zi-li Ren (Department of Biology, Nankai Nniversity, Tianjin 300071, China) , En-yun Yao, Tian-Lin Liu and Zheng-ming Li (Research Institute of Etemento-organic Chemistry, Tianjin 300071, China)

Semiothisa cinerearia is a serious defoliator of Sophora japonica which is advocated as one of the major trees to be planted among cities in northern China. One of the controt measures of the pest in consideration will be the apptication of sex pheromone technique. The major pheromone component was identified as Z,Z-6,9,-cis-3,4-epoxy-heptadecadiene, the minor component was Z,Z,Z-3,6,9-heptadecatriene. The activities of the two pheromone components were compared with the natural pheromone extracts by etectroantennogram assay. It showed that Z,Z-6,9-cis-3,4-epoxy-heptadecadiene elicited higher recetor potentiat than Z,Z,Z-3,6,9-heptadecatriene did. Stimulation by 1ug of Z,Z-6,9-cis-3,4-epoxy heptadecadiene caused average receptor potentiat of 2.7mV which could be elicited by about 10FE extract of sex pheromone glands. It suggested that 1FE extract of sex pheromone gland might contain 0.1ug of the major pheromone component. The threshold amount for the major pheromone component was found to be 0.001ug, while that for the minor component was as high as 0.1ug.

#21

The Behavioural and Electrophysiological Response of Turnip Moth Males *Agrotis segetum* to Fluorinated Pheromone Analogues. Wu Wenqi, Marie Bengtsson, Bill S Hansson, Tommy Liljefors, Christer Löfstedt and Mats Svensson (Department of Ecology, Lund University, S-223 62 Lund, Sweden), Glenn D Prestwich and Wei-Chuan Sun (Department of Chemistry, State University of New York, Stony Brook, NY 11794-3400, USA)

The electrophysiological and behavioural responses of male *Agrotis segetum* to fluorinated analogues of (*Z*)-5-decenyl acetate (Z5-10:OAc) were investigated. The single sensillum recordings showed that 4,4-difluoro-(*Z*)-5-decenyl acetate (4,4-F2), 7,7-difluoro-(Z)-5-decenyl acetate (7,7-F2), 10,10,10-trifluoro-(Z)-5-decenyl acetate (10,10,10-F3) and 7,7,8,8-tetrafluoro-(Z)-5-decenyl acetate (7,7,8,8-F4) were each 100-fold less active than the natural Z5-10:OAc, while the 7,7,8,8,9,9,10,10,10-nonafluoro-(Z)-5-decenyl acetate (F9) analogue was approximately 10 000-fold less active. A mixture of Z5-10:OAc, Z7-12:OAc, and Z9-14:OAc on a filter paper dispenser was proved to be as attractive as female gland extracts when tested in a flight tunnel. With Z5-10:OAc omitted, the two-component mixture elicited a significantly lower male response. Four analogues: 7,7-F2, 10,10,10-F3, 7,7,8,8-F4 and F9 were added separately to the two-component mixture in the same amount as Z5-10:OAc had been present. The responses elicited by the mixtures containing the 7,7-F2, 10,10,10-F3 and 7,7,8,8-F4 analogues were comparable to the activity of the natural three-component mixture, whereas the response elicited by the F9-containing mixture was as low as the response to the two-component mixture. In a field test the 10,10,10-F3 and 7,7,8,8-F4 containing mixtures show a significantly more active than the two-component mixture, while the F9-mixture was as low activity as the two-component mixture. The strongly reduced activity of the F9 analogue was suggested mainly due to the low affinity between the perfluoroalkyl moiety and the highly lipophilic pheromone receptor site.

#22

3,6,9-TRIENES, 6,9-DIENES AND THE EPOXY DERIVATIVES; SEX ATTRACTANTS FOR GEOMETRID AND NOCTUID MOTHS DISTRIBUTED IN JAPAN

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(3Z,6Z,9Z)-Triunsaturated and (6Z,9Z)-diunsaturated hydrocarbons with C19 - C21 straight chains were synthesized starting from linolenic and linoleic acids, respectively. Each triene was treated with m-chloroperoxybenzoic acid to yield a mixture of three monoepoxydienes in a ratio of ca. 1:1:1. After separation by preparative TLC, chemical structure of each epoxide was assigned by 2D-NMR techniques. One mg of each synthetic chemical was applied to a rubber septum, which was placed in a sticky trap, and field screening tests were carried out in a forest in Tokyo (Hachioji-shi). Up to date, attraction of eight geometrid species and two noctuid species was successfully observed as shown in the following table.

[Geometridae]			
Agathia carissima	Z3,Z6,Z9-20:H[a)]	Agathia curvifiniens	Z6,Z9-21:H
Alcis angulifera	epo3,Z6,Z9-19:H[b)]	Alsophila japonensis	Z3,Z6,Z9-19:H
Ascotis selenaria	epo3,Z6,Z9-19:H	Epirrita viridipurpurescens	Z3,Z6,Z9-21:H
Pachyodes superans	Z3,Z6,Z9-20:H		
Sibatania mactata	Z3,Z6,Z9-21:H		
[Noctuidae]			
Paracolax pryeri	Z3,epo6,Z9-20:H	Rivula sericealis	Z3,epo6,Z9-19:H

a) (Z,Z,Z)-3,6,9-eicosatriene. b) (Z,Z)-6,9-cis-3,4-epoxynonadecadiene.

#23

FEMALE CHEMICAL AND PHYSICAL FACTORS REGULATING MATING BEHAVIOR OF THE MALE YELLOW-SPOTTED LONGICORN BEETLE, PSACOTHEA HILARIS (PASCOE) (COLEOPTERA: CERAMBYCIDAE). Midori Fukaya, Hiroshi Honda (Department of Agrobiology, The University of Tokyo, Tokyo 113, Japan)

The male mating behavior was elicited by contact sex pheromones in female surface wax. The pheromonal activity was found in two fractions in silica gel CC of the female extract. In the non-polar fraction, C_{25}-C_{35} hydrocarbones were identified by GC and GC-MS, while a pregnenedione-like compound was found in the polar fraction. When the males were exposed to artificial female models treated with the extract, they showed various behavioral responses depending on morphological and morphometrical differences of the extract-laden models. An optimal size of the model consists with the average body size of natural females. The height of the model was a decisive factor at the early stages of mating behavior: recognition of pheromone and orientation. But shape of models was so at the late stages of mating behavior: holding and copulation. In brief, both contact pheromones and physical factors on the female body were essential for eliciting the normal mating behavior of the males of this beetle.

#24

PRIMARY STUDY OF THE SOURCE OF CHEMICAL SIGNAL IN CABBAGE BUTTERFLY, PIERIS RAPAE (LEPIDOPTERA, PIERDAE). Shi-zhen Ren and Duan-shue You (Institute of Zoology, Academia Sinica, Beijing 100080, China).

All insects used in this study were obtained from the cabbage field around the Beijing Agricultural University. Source of the chemical signal was experimentally testified by field bio-assay of the redistilled hexane extraction of both female and male forewing and hindwing. The sticky traps used in the tests were constructed from either white or yellow plastic plates, while the white ones are more effective for attraction. Results of field bio-assays showed that the extraction of wings of both sexes could catch more males than females. In comparing the effectiveness in traping, the female hindwing extraction with which baited in a trap could catch 116 butterflies in a day, had been proved the most efficacious. It is suggested that tne female hindwing may be the major source of chemical signal in cabbage butterfly.

#25

BOUQUETS AND BLENDS: ANALYSIS OF BEHAVIOURAL AND PHYSIOLOGICAL RESPONSES TO EXOCRINE SECRETIONS OF *CAMPONOTUS.*

R M Crewe & P G Hawkes, Dept of Zoology, University of the Witwatersrand, Johannesburg, South Africa

The chemical composition of the secretions of Dufour's gland, poison sac and mandibular glands of workers a number of *Camponotus* species was determined using GC-MS analysis. An equivalent analysis was conducted on male mandibular glands.

The behavioural responses of workers to these exocrine secretions was recorded using a video recorder. In addition, physiological responses of the individuals was measured using a CO_2 analyzer.

The results demonstrate that there are caste differences in response to male exocrine secretions and to worker secretions. In addition, the mechanism of response to blends from a single glandular source and to blends that are produced from combinations of different glandular secretions will be discussed. This data wil be used to evaluate the validity of the Bossert-Wilson model for the generation of active spaces for the signals.

#26

ON THE EXOCRINE COMPOUNDS OF BLACKWINGED SUBTERRANEAN TERMITES (ODONTOTERMES FORMOSANUS SHIRAKI). Zhenhua Zhang (Institute of Biology, Hangzhou University, Hangzhou 310012, China), Zhaoliang Dong (Instutite of Termite Control of Quzhou, Zhejiang, China), Xianwen Pang (The Center of Analysis and Measurent, Zhejiang University, Hangzhou, Zhejiang, China)

The exocrine compounds of Odontotermes formosanus were extracted with n-hexane and analyzed by GC/MS. The defensive compounds from soldier caste are fatty acids derived (3 compounds without formic acid), hydrocarbon (8 compounds) and alkyl phenol (1 poison compound). There is no contact poisons from worker caste.

#27

A COMPUTERIZED SYSTEM FOR ACQUIRING AND MEASURING WAVEFORMS FROM AC ELECTRONIC INSECT FEEDING MONITORS. Ned M. Gruenhagen, Elaine A. Backus (Department of Entomology, University of Missouri, Columbia, MO. 65201), Diane E. Ullman (Department of Entomology, University of Hawaii, Honolulu, HI. 96822), and Aubrey Moore (University of Guam, CALS, Mangilan, Guam 92923).

We have developed a computerized system to collect, display and measure waveform data output from AC insect feeding monitors using commercially available hardware and software for an IBM-AT compatible computer. Analog signals from up to 8 channels are converted to digital form and stored on a Winchester (Hard) Disk. The data are copied to a database program and additional variables are added. A waveform generated from data from a single channel is graphically displayed in a window within the database program. Using a mouse, the user scrolls across the displayed waveform and identifies the beginning of specific events such as a waveform or probe, etc. by entering a value in a numerical listing of the data displayed in a second window. Once all events are identified, the database is uploaded to a mainframe computer and analyzed statistically. Our system speeds the measurement and analysis of waveform data collected from feeding studies of piercing - sucking insects. Examples will be demonstrated.

#28

THE BEHAVIOURAL EFFECTS OF AN APHID ANTIFEEDANT, POLYGODIAL, AS REVEALED BY VIDEO OBSERVATIONS AND ELECTRONIC MONITORING OF STYLET PENETRATION Jim Hardie, Glen Powell (AFRC Aphid Biology Group, Imperial College at Silwood Park, Ascot, Berks SL5 7PY, U.K.) and John A. Pickett (Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ, U.K.).

Stylet penetration by apterous *Aphis fabae* (Scopoli) and *Myzus persicae* (Sulzer) was examined using simultaneous close-up video and electronic recording techniques. In both species stylet penetration was correlated with the cessation of body and antennal movement and the recommencement of antennation indicated stylet withdrawal. These techniques were used independently to investigate the antifeedant effects of (±)-polygodial. Upon initial plant contact the stylet penetration parameters (time to first penetration; number of penetrations; mean penetration duration and total penetration times), with the exception of duration in *M. persicae*, were not significantly different between polygodial- and solvent-treated surfaces. However, these parameters were found to differ when aphids were held for prolonged periods on polygodial- as compared to solvent-treated surfaces prior to behavioural examination. It appears that the effects of polygodial are not immediate.

#29

THE EAG RESPONSES OF APHIS GLYCINES TO THE VOLATILES OF ITS HOST PLANT. Yong-jun Du, Xin-li Han, Fu-shun Yan (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Soybean aphis, Aphis glycines M. is a heteroecious species, and its winter and summer hosts are buckthorn, Rhamnus davutius, and soybean, Glycine max, respectively.

The response of soybean aphis to plant volativles was studied by making use of the EAG technique. The EAG recordings showed (1) that A.glycines antennal olfactory receptors responded differentially to plant volatiles, hexanal being the most effective in 40 tested chemicals, followed by trans-2-hexen-1-al, hexanol and 1-heptanol, (2) that the EAG responses of the adult apterae virginoparae to volatiles were higher than those of the alatae, but relative percentages of the responses to cis-hexen-3-ol-1 do not differ significantly, and (3) that the EAG responses of aphis to the v acuum-condensed extracts of the buckthorn foliage were higher than to those of the soybean foliage. Furthermore, two extracts were separated by GC, and some of the fractions, being identified, could evoke a sizable EAG response. It is inferred that the profile composed of some components in these fractions plays a crucial role in soybean aphis' olfactory orientation during its host alternation.

#30

THE OLFATORY RESPONSES OF APHIS GLYCINES TO THE VOLATILES OF DIFFERENT PARTS OF SOYBEAN PLANT.Xin-li Han, Yong-jun Du, Yan-fu Shun(Institute of Zoology, Academia Sinica,Beijing 100080,China)

Aphis glycines is an important pest on the soybean plant in China. The aphis feeds on the terminal buds, tender stems and leaves, but not on the cotyledons, which is different from Myzus persicae. The electrophysiological experiments indicated that the EAG responses of A. glycines to the uncut and cut leaves and stems were much higher than those to the cotyledons, and that the EAG responses of A.glycines to the crude extracs of the fresh leaves and stems were much higher than that to the extracts of cotyledons too. Moreover, behavioral tests had shown that olfactory attraction of A.glycines by fresh leave and stem vapours were higher than by the cotyledon vapours.

The olfactory responses of A.glycines to the volatiles of different parts of the host were different. It is suggested that apart from the factors of the stucture and the nutritional supply of the plant tissue, the volatiles play a role in aphis' selecting the feeding sites on the host plant.

#31

INFLUENCE OF SUITABLE AND UNSUITABLE PLANTS AND THEIR EXTRACT ON THE FEEDING BEHAVIOR OF *NEPHOTETTIX VIRESCENS* DISTANT. Jianjun Liu* and Shozo Takahashi (Pesticide Research Institute, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan. * Present address: Biological Control Institute, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

A rice variety 'Nihonbare' was selected as a suitable and *Leersia hexandra* as an unsuitable plant for *Nephotettix virescens* by the value of intrinsic rate of increase. The feeding behavior on both plants was investigated through analysis of honeydew composition and recording of ingestion pattern through an electronic measurement device (EMIF). Although a certain amount of honeydew was excreted on both plants, there was less sugar content and no sucrose in the honeydew from unsuitable plant. No phloem ingestion waveform was recorded on the unsuitable plant absolutely. The influence of the extract from both plants on the survival and feeding behavior of *N. virescens* was investigated. The water soluble extract of unsuitable plant caused high mortality in *N. virescens*, while that of suitable one did not. The basic fraction of water soluble extract was proved to be major ingredient. The amphoteric fraction was found to be beneficial for its survival. Feeding behavior recorded on EMIF showed that the ingestion duration of *N. virescens* became shorter when the basic fraction was added to the sucrose solution as compared with sucrose alone or with amphoteric fraction added. An phloem ingestion pattern was recorded when *N. virescens* fed on sucrose solution added with the amphoteric fraction.

#32

INFLUENCE OF HOST ALTERNATION ON THE FEEDING BEHAVIORS OF *Empoasca fabae*. Xinzhi Ni, Elaine A. Backus and Ned M. Gruenhagen (Department of Entomology, University of Missouri, Columbia, MO 65211, U.S.A.)

The feeding behaviors of two cohorts of potato leafhoppers (PLH), *Empoasca fabae* (Homoptera: Cicadellidae), were tested. One cohort (23 insects) was exposed to alfalfa plants since the insects were the 4th instar nymphs (or conditioned for eight days). The other cohort (23 insects) was conditioned on alfalfa when the insects were one day old adults (or the insects only conditioned on the alfalfa plants for 2 days). The waveform from AC Electronic Monitoring System showed that the PLH's changed their probing behavior when they had different amounts of prior experience on alfalfa plants. The mean probing duration for each cohort of insects was not significantly different. Both cohorts of the insects fed for 90 minutes within two-hour recording period. The mean number of the probes made by each cohort was not significantly different statistically ($F=2.84$, $df=1$, $P>0.05$). However, nymphal-conditioned insects made significantly more probes with I_c waveform than adult-conditioned insects ($X^2=43.23$, $P<0.01$). The mean duration of a probe in the nymphal-conditioned PLH's was significantly longer ($F=13.48$, $df=1$, $P<0.01$) than a probe made by adult-conditioned insects. Even within a probe, the nymphal-conditioned PLH's had significantly longer I_a duration ($F=13.51$, $df=1$, $P<0.01$) and longer I_c duration ($F=9.94$, $df=1$, $P<0.01$) than the adult conditioned ones. This phenomenon might be caused by learning, or nutritional requirements of the PLH's. All the possible causes of this phenomenon would be investigated in further studies. In addition, the feeding behaviors of the migrants collected in the early spring and their offsprings collected in the summer would also be compared.

#33

OLFACTORY RESPONSE OF MYZUS PERSICAE TO PLANT VOLATILE COMPONENTS. Fu-shun Yan, Yong-jun Du, Xin-li Han(Institute of Zoology, Academia Sinica, Beijing 100080, China)

The olfactory response of Myzus persicae was stutied with electro-antennogram(EAG) technique to 40 plant volatile components which might function in host plant selection of the insect. The results were as follows:

1. The insect showed high sensitivity in response to some of the chemicals: highest to 1-hexanol and hexanal; higher to 1-heptanol, trans-2-hexen-1-ol, trans-2-hexen-1-al, cis-2-hexen-1-ol and cis-hexen-3-ylacetate.

2. The insect was also very sensitive to β-pinen and α-pinen, especially the alate virginoparae from soybean plant was very sensitive to the stimulant of β-pinen.

3. The sensitivities of EAG responses were significantly different amongest the insects from different host plants.The average relative sensitivity of the insects from soybean plants was 1.4 times to that from tobacco plants of the same green house. It was inferred that aphids feeding on less suitable host olant would increase its sensory sensitivity to the semiochemicals, and this fact is presumably significant for survival of the species.

#34

ABILITY OF THE WHITEFLY, *PARABEMISIA MYRICAE*, TO DISCRIMINATE LEAF AGE PRIOR TO PROBING. G. P. Walker, N. Zareh (Department of Entomology, University of California, Riverside, CA 92521, U.S.A.)

Behavior of adults of the whitefly, *Parabemisia myricae*, was studied in a variety of experimental conditions on young and mature lemon leaves (*Citrus limon*) and on artificial leaves constructed of green paper wrapped in parafilm. The insects were allowed to walk onto the leaves and were scored according to whether they initiated a probe upon their first encounter with the leaf or whether they left the leaf without probing. The whiteflies initiated probes significantly more frequently on young than on mature leaves. Additionally, in all experiments, the proportion of whiteflies that probed on artificial leaves was intermediate between the proportions that probed on young and mature leaves. The same results were obtained when whiteflies were deprived of normal visual stimuli (when the observation arena was illuminated with red light only in wavelengths $\geq$ 580nm) and when antennal flagella were ablated (antennal segments 3-7). Additional experiments were conducted to determine if initiation of probing was affected by certain classes of leaf chemicals: probing behavior was observed on untreated leaves (controls) and on leaves dipped in chloroform to remove surface waxes, or dipped in 70% methanol to remove surface phenolics, or steam distilled to remove essential oils.

#35

THE INTRA-SPECIFIC BEHAVIORS OF CERAMBYCIDS (COLEOPTERA:CERAMBYCIDAE). Jing-qiu Cheng (Department of Plant Protection, Southwest Agricultural University, Chongqing, 630716, China)

The investigations on encountering, mating, fighting, and stridulating behavior in 9 species of adult cerambycids were conducted in 1988 and 1989. The encountering process between beetles of the same sex is simply performed by behavior of evading or fighting against each other in females and evading, standing facing or fighting in males. However, in most case, encountering between sexes will lead the adults into the mating process which is performed by a series of behaviors including pursuing, capturing, mounting, tapping, licking, fighting, copulating in males and running away, fighting, unreceiving, receving, copulating in females. Though fighting behavior was observed in many species, it takes place mainly in some species of males and may be displayed in different ways such as touching with antennae, pushing with body and legs or biting against each other. While the most violent fighting was observed between males in the process of fighting for female. Males' stridulating may be associated with fighting, capturing, mounting or copulating behaviors depending on species. The investigation revealed that cerambycids have their species-specific behavioral patterns and the males display more behavioral types than females though some outlines could be constructured.

#36

FEEDING PREFERENCES OF THE FOURTH-INSTAR LARVAE OF THE EASTERN SPRUCE BUDWORM TO PURE CARBOHYDRATES. C. Guertin[1], J. Cabana[2] and M. Arella[1] ([1] Institut Armand-Frappier, Laval, Québec, CANADA, H7N 4Z3 / [2] Gouvernement du Québec, Ministère des forêts, Ste-Foy, Québec, CANADA, GIP 3W8).

The eastern spruce budworm, *Choristoneura fumiferana* (Clem.) is an important defoliator of the coniferous forest in eastern North America. The effects of 12 pure carbohydrates (25 mM) on the feeding behaviour of the fourth-instar larvae were investigated in a two-choice feeding test. The results suggested that the young instar larvae showed a strong preference for sucrose, followed by fructose. No significant preference was observed for other sugars. The effects of the variation of sucrose concentration on the feeding behaviour of the instar larvae were also monitored. The response of the larvae was characterized by a pattern resembling that of a bimodal curve. The application of these results in a biological control approach is discussed.

#37

PLANT SECONDARY SUBSTANCES IN MILLETS CONTROLLING HOST SELECTIONS OF PLANTHOPPERS. Chul-Sa Kim (Faculty of Agriculture, Kochi University, Nankoku, Kochi 783, Japan)

Three species of planthopper, Nilaparvata lugens, Sogatella furcifera and Laodelphax striatellus, are pests of rice plant in most Asian countries with different feeding behavior as regards host selection in gramious cultivated plants as shown in the Table below.

	N. lugens	S. furcifera	L. striatellus
Rice plant	+	+	+
Japanese barnyard millet	−	+	+
Finger millet	−	−	+
Indian barnyard millet	−	−	±

In the course of studies on the biological and chemical basis of these phenomenons, we have come to the conclusions that the resistance of these millets to each planthopper species is due mainly to the presence of multiple antifeedants and that the inhibitory activity for feeding is not attributable to a single component but to several combined components. We isolated nine acidic compounds from finger millet, eight from Indian barnyard millet, and six from Jpanese barnyard millet as antifeedants for N. lugens respectively.

#38

IDENTIFICATION OF FLYING INSECTS USING AN ARTIFICIAL NEURAL NETWORK TO RECOGNIZE WINGBEAT SPECTRA. Aubrey Moore (Northern Marianas College, Saipan MP96950, U.S.A.)

Natural or artificial light reflected from the wings of an individual flying insect can be recorded using a photosensor. Spectral analysis of a typical recording reveals a harmonic series with the wingbeat frequency as the fundamental. Wingbeat spectra can be used to identify flying insects in much the same way the human ear and brain identify musical instruments by their characteristic audio spectra. In an experiment using the mosquitos Aedes aegypti (L.) and A. triseriatus (Say), an artificial neural network was trained to identify species and sex with high accuracy. This technology could provide the basis for an insect flight monitor which automatically counts and identifies species of interest.

#39

MEMORY, RECOGNITION AND CRADLE FORMATION IN SOME SPECIES OF *Euops* (ATTELABIDAE, COLEOPTERA). Kazuhiko SAKURAI (Dept. Zool., Fac. Sci., Kyoto Univ., Kitashirakawa, Sakyo, Kyoto, 606-01 Japan)

In Attelabinae *Euops* is a unique genus in respect of its breeding habit as well as morphology. The female weevil utilizes a marginal area of a leaf (cradle section, CS) for a cradle by cutting the leaf. The CS is a long belt, though its shape differs among weevil species: the cutting line generally runs parallel to the leaf periphery.

The aims of this study was to describe their cradle formation behaviour, and also to reveal female's recognition system underlying the characteristic leaf cutting. Observation of the behaviour was done in several species and experiments on female's recognition were made only in *E. splendidus*. The results of the experiments indicated the female weevil measured the length of CS on the leaf and made a nibbled mark as the terminal of the cutting, and started cutting. During the intermittent cutting, she recognized leaf shape probably through the periphery walking. She used memory of the length of CS remaining uncut to return the temporally front of the cut.

All species studied performed similar behaviour as *E. splendidus* did and this suggested they had a similar recognition system; variation of some cradle formation behaviours (e.g. marking, cutting, folding) within the genus *Euops* is discussed and compared with other Attelabinae.

#40

TEST ON THE SPEED AND DURATION OF TETHERED FLIGHT IN DRIED FRUIT BEETLE, CARPOPHILUS HEMIPTERUS (NITIDULIDAE, COLEOPTERA). Zhenquan Wu (Biological Control Research Institute , Fujian Agricultural College, Fujian 350002, China), Roger Laughlin (Department of Entomology, Waite Agricultural Research Institute, Australia)

The duration and speed of tethered flight by *Carpophilus hemipterus* were studied. A large proportion of females and males individuals tested flew for short period (<30 mins.). Only a small proportion of adults had capacity for long-distance migration (>30 mins.). The flight duration of female adults was longer than that of males. The longest recorded flight, of 6.3 hours, was by a female. The average of the flight speed of female and male was 1586 meters and 1195 meters per hour respectively. The flight speed of females was faster than that of males. Male adults did not fly after mid-night. Females are better fliers than males.

#41

THE BIOLOGY OF ADULT FRUIT FLY Tetradacus citri (Chen) UNDER LABORATORY CONDITION (DIPTERA: TEPHRITIDAE). You-pin Yin, Jing-qiu Cheng (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

After a dormant pupal stage about 3--4 months under room temperature, the adults of fruit fly, Tetradacus citri (Chen), are emerged from Feberary to May next year. The flies were reared with a diet of 5 percent honey solution plused 2 percent yeast and had the life-span as long as 70 days. After a period more than 22 days for their sexal maturity, mating behavior of the flies were observed from morning to afternoon but frequently in 12:00--15:00. Though polygamy has not been observed in females, males may copulate once or twice and a few three times. Oviposition occures next day after copulation. Females prefer ripe fruit to immature one and several females may oviposite on a sweet orange at the same time under the laboratory condition. Both sexes showed no obvious response to the extractions prepared by the body of male or female with ether and methane. However, in a few celimeter's distance, some behaviors by females such as mouthparts streching, body turning and front legs moving could be observed.

#42

LABORATORY SRUDIES ON THE MATING BEHAVIOUR OF OXYNA. PARIETINA (L.) (DIPTERA: TEPHRITIDAE). Zhang Fangyao (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou, 310029, China), Thomas Hoffmeister and Hubert Pschorn-Walcher (Zoologisches Institut, Biozentrum der Universität, D-2300 Kiel, Germany)

The mating behaviour of Oxyna parietina (L.) was studied in the laboratory. Under laboratory conditions (20°C, 16L:8D), some female and male flies began to copulation at the day of emergence, and after 3 and 4 days respectively, all male and female flies had mated at least once. At the day of emergence the ovaries of the femele flies were well developed. 22.4% dissected female flies had mature eggs at the 2nd day after emergence, and at the 4th day all dissected female flies had mature eggs. During their sexual activity, male flies courtshiped female flies in a typical manner: rapid wing vibration. In successful copulation, 80.4% male flies approached female flies frontal, 76.1% male flies mounted the abdomen of female flies frontal. The time duration of copulation ranged from 52 to 221 min., with an average of 147.9 min. If the female flies was not receptive, she might repel copulatory attempts in 3 typical ways.

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INVESTIGATING THE LARVAL BIOLOGY OF THE VELVETLEAF SEED BEETLE, (Bruchidae: Althaeus folkertsi): WITHIN THE VELVETLEAF SEED (Abutilon theophrasti).

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The velvetleaf seed beetle completes it's larva development from first instar through pupation within a single velvetleaf seed. The resulting seed destruction by velvetleaf seed beetles, could contribute to natural control of the velvetleaf weed. However, little is known about the life history of this insect, especially it's development within the seed. To investigate the larval development, an ultrasonic signal detection device (biomonitor) was used to record feeding events within the seed. Seed feeding insects emit ultrasonic signals when seed tissues are struck during feeding. Six first instar larvae were collected as they were entering velvetleaf seeds. Seeds where first instar larvae were observed boring through the seed coat were placed on the biomonitor to record feeding events. Temperature and high frequency signals emitted at 40KHz were recorded for a period of 4 weeks at one minute intervals. Periodic cessations of larval feeding activity within the seed correspond to larval molts. The feeding events plotted over time can reasonably represent the number of molts and feeding durations within the seed.

STUDIES ON SEX PHEROMONE OF SUGARCANE BORER IN CHINA

Wu Deming
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The sugarcane stem borer, Chilo infuscatellus S., the sugarcane stripped borer, Chilo venosatus W.,and the sugarcane tip borer, Scriphaga excerpalls W. are three of the most impotant on the sugarcane pests in south China. Their chemical structures of sex pheromones were identified from female's of gland by Wu Deming et al. in China. In fact, these pheromones are very efficient by themself for luring males in the field. Mass trapping experiments of sugarcane stem borer by using 30 water traps/ha with rubber stopper dispensers and 1500 rubber septa/ha for mating disruption were applied to controlling the first generation male moths in Guangxi and Shichuan province on total area of 1500 ha from 1983 to 1991. The experiments of mating disruption for sugarcane stripped borer were conducted in Guangdong province with 3000 tube polyethylene dispensers per ha to disruption the second and the third generation male moths on total area of 12000 ha From 1987 to 1991. During all the experiment of the mating disruption, catchs males in sex pheromone traps very low indicating more than 99% disruption. These methods have show that pheromone treatment can reduce sugercane borer damage with standard insecticides control.

THE EFFECTIVENESS AND APPLICATION TECHNIQUES OF BUPROFEZIN IN CONTROLLING GREENHOUSE WHITEFLY, TRIALEURODES VAPORARIORUM Guo-ren Zhu, Zheng-li Ju, De-lu Qiao, Jian-zhou Zhao, Bao-yun Xu (Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, Beijing 100081,China)

Studies were carried out in experimental and commercial greenhouses in Beijing to evaluate the effectiveness of Buprofezin, an insect growth regulator, against the greenhouse whitefly and the application techniques. Buprofezin was proved to be highly effective against the nymphs, less effective to eggs and little to adults of the whitefly. It was important to apply Buprofezin when the density of whitefly adults was low in early season. It was suggested that in Chinese common greenhouses, Buprofezin should be applied at 125 ppm when the density was lower than 2.7 adults per plant, and at 250 ppm mixed with 5 ppm of Bifenthrn when more adults were found. In large scale greenhouses, Buprofezin was applied during transplanting period at 167 to 250 ppm, followed by releasing Encarsia formosa. The integrated technique was proved to be highly effective and economic in protecting tomato and cucumber production in Beijing, with the yield and net income increased by 10-15%.

SUBSTRATE SPECIFICITY OF THE REDUCTASE IN THE PHEROMONE BIOSYNTHESIS OF THE ASIAN CORN BORER, OSTRINIA FURNACALIS. Cheng-hua Zhao, Fang Lu(Institute of Zoology, Academia Sinica, Beijing 100080,China), Christer Löfstedt(Department of Ecology., Lund University, Lund, Sweden)

A series of tetradecenoic acids, varying in position from 7 to 13 and geometry of double bonds, and 14-(D_3)-tetradecenoic acid were applied to the sex pheromone glands of female O. furnacalis. Each application contained one of the fatty acids and (E)-11-tetradecenoic acid in equal amount as a metabolic standard for comparison of the relative conversion of the fatty acids to acetates. Capillary GC analyses of extracts of the treated glands showed most of the fatty acids were converted to the corresponding acetates in very different relative conversion, but (Z)-7-tetradecenyl acetate was not detacted. In general, the relative conversion of E isomers were significantly higher than that of corresponding Z isomers, except for 11-tetradecenoic acid in which much more Z isomer was converted to the product. Because earlier experiments have demonstrated that the acetyltransferase has no specificity for tetradecenols with different position and geometry of double bonds and tetradecenol, these results indicated that the reductase in the pheromone biosynthesis of O. furnacalis has high specificity.

STUDIES ON THE SEX PHEROMONE OF ECTROPIS OBLIQUE PROUT. Kun-shan Yin, Bei-bian Hong(Institute of Tea, Chinese Academy of Agricultural Science, Hangzhou 310008, China), Zhi-zhen Shang (Institute of Elemento-Organic Chemistry, Nankai University, Tianjin 300071, China)

Ectropis oblique Prout is a major pest which can cause serious damages to tea cultivation in China. The components of E.oblique's sex pheromone are hitherto unreported. From all the evidences the morphology, histology and scanning electron microcopy studies reveal that the pheromone gland is situated at the area between the 8th and 9+10th abdominal segments. The methods used for collecting sex pheromone are: (A) excising abdominal tips from two days old virgin females, kept in 6-8 hr. dark cycle at 15-20℃ during their optimal calling period dichloromethane. (B) rinsing and washing the abdominal tip with small quantities of hexane or (C) using the Porapok Q. to collect the sex pheromone. All of these methods are successful for quantitative analysis by HPLC and GC/MS. EAG response profile and laboratory bioassay with a wind tunnel are used to monitor and isolate the bioactive fractions,then GC/MS for identification of pheromone of E.oblique, (Z, Z, Z)-3,6,9-octodecatrinc, (Z, Z, Z)-3,6,9-nonadecatrinc and (Z, Z)-3-9-cis-6,7-epoxyocotodecadiene are likely the main components of this system. A further study including field tests will be followed in the future.

EFFECTS OF ALTERING THE COMPOSITION OF ARTIFICIAL DIET ON THE LARVAL GROWTH AND DEVELOPMENT OF HARMONIA AXYRIDS. Zhi-hui Chen(Institute of Zoology, Academia Sinica, Beijing 100080,China)

The results showed that the pupation rate was up to about 97% when the larvae were fed with an artificial diet composed of fresh pork liver homogenate and sucrose enriched with suitable lipids,the larval stadium was shortened and the survival rate in the late instars was increased. The effective lipid components were vegetative oils including olive oil(0.1%) and soybean oil(1%). The concentration of free amino acids in the artificial diet was lower than that in the natural prey (aphids), but the diet contained higher level of total protein, which, however, seemed not well utilized by the larvae. Addition of yeast hydrolysate could improve the growth and survival rates of the larvae considerably but adding yeast powder had only little effect.. When feed on this diet the larvae showed much similarity to those fed on aphids in growth and development.

INFLUENCE OF NUTRITIONAL FACTOR ON THE RELEASE RATE AND THE RATIO OF TWO ISOMERS OF SEX PHEROMONE OF PINK BOLLWORM *PECTINOPHORA GOSSIPIELLA*. Chang-ben Huang, Wen-gu Li, Wen-jun Fu (Shanghai Institute of Entomology, Academic Sinica, Shanghai 200025, China)

Pink bollworm(PBW) generally occurred three generations per year in China. As the larvae reared on various diets, the difference of sizes among generations were distinct. In this research, the release rate and ratio of two isomers of sex pheromone released by females collected from cotton field in different generations and reared on artifical diet of PBW were quantitatively determined by airborn of single sex gland. The mean release rate of sex pheromone of overwinter generation of PBW is higher (3.52±1.42ng/10min.), the second generation is 2.84±1.12ng/10min.; and the first generation is only 1.83±0.51ng/10min.; the strain reared on artifical diets is 2.62±1.75ng/10min.. There are singificant differences among generations ($p<0.01$). No matter the PBW were reared on any diets, the ratio of two isomers (Z,Z-7,11-16:Ac and Z-7,E-11-16:Ac) are maintained within the range of 54.8±1.2:45.2±1.2. We also found that the release rate of sex pheromone are highly correlated with the weight of female pupae on the same diet. This is the fact that the release rate of sex pheromone of female PBW were concerned with absorbed nourishment during the larvae period. But the nutrition did not influnce on the ratio of the two componentes of sex pheromone which is genetically stable.

STUDY ON TWO-PHASE BT PRODUCTION TECHNOLOGY. Qing-sheng Jin, Xiao-dong Wang, (Institute of Biology, Hebei Academy of Sciences, Shijiazhuang, 050081, China)

The two-phase BT production process was that the liquid strain produced by small sub-fermentation culture equipments was inoculated into solid medium, then tradational Chinese shelf disk culture method was adopted in order to process solid fermentation. The characteristics of the process included that special strain could protect openning solid culture from phage and bacteria contamination; temperature, moisture and air condition required by BT growth could be satisfied; adopted microcomputer temperature monitor could reduce labour intensity and contamination. The two-phase process was suitable to developing areas in production of BT agent for the investment of the process was 5% of sub-fermentation process and the cost reduced about 60%. By the study of the effects affecting the solid fermentation, the active spore number of the product came up to 15 billion per gram. The crystal size and the ratio were higher than those of sub-merged fermentation. The toxicity of the product to target insects was verified through field test.

STUDIES ON THE ARTIFICIAL DIET AND REARING TECHNIQUE OF CARPOSINA SASAKII MATSUMURA LARVAE. Chun-shu Piao, Yuan-zhen Jiang (Research Institute of Pomology CAAS, Xingcheng 121600, China).

Experiment on the artificial diet and rearing technique of C. sasakii Matsumura has been done since 1983. The result showed that C. sasakii Matsumura has grown 40 generations continuously on 85-A The cost is relatively low and getting 100 larvae needs 0.23 yuan only, which is 1/8 of the apple as diet. Moreover, the rearing method is simple, practical and suitable for mass rearing and reproduction.

A STUDY OF OPTIMAL TEMPERATURE FOR REARING RICE MOTH (CORCYA CEPHALONICA STAINTON). Xiao-xiu Zhang, Yun-ning Zhou, Mei-li Lian, Jun-sheng Zhao, Tang Li (Shanxi Plant Protection Institute, Taiynan 03003), China)

According to the data, rice moth is a thermophilic and hygrophilic insect, optimal temperature and optimal relative humidity of air for rearing is 27-30℃ and 70-80%. In our experiment, temperature is set between respectively 20-32℃ and divided into 5 treatments: 20, 23, 26, 29, 32℃. On the basis of statistical analysis of the data observing 13 features of development of rice moth egg, larva, pupa and imago, we suggested that the temperature between 20 and 32℃ is appropriate for it growing and the temperature between 26 and 32℃ is optional. The temperature can be reduced to 20-26℃ in order to diminish energy losses during the process of heating.

STUDY ON TRANSMISSION OF LONGAN WITCHES' BROOM BY TESSARATOMA PAPILLOSA DRURY. Xu Changfan, Chen Jingyao, Xia Yuhua and Ye Chung (Fruit Research Institute, Fujian Academy of Agricultural Sciences)

The test of transmission by varied instar nymphs, transmiting witches' broom from longan to litchi and determination of latent period of pathogen in litchi stinkbug were conducted in screened insectary. The results show that the longan witches' broom can be transmited by 3-5 instar nymphs of litchi stinkbug but not by 1-2 instar ones. The witches' broom can be transmited from longan to litchi by both adults and nymphs of litchi stinkbug. The symptoms of witches' broom on litchi are similar to that on longan. The latent periods of pathogen of witches' broom in litchi stinkbug are shorter than 4 days minimum and longer than 35-245 days maxamum. The most adults only transmited a longan plant in their lives.

THE PROSPECT OF ANTS IN HEALTH CARE AND THERAPY. Zhicheng Wu. (Naning Jinling Ant Therapy Center. Nanging, China)

Our country is the native place for dietotherapeutic use of ants. For over 2. 000 years , the habit of taking ants as food and medicine has been popular in various regions of our country. In the past ten years. the practice of using ants for therapy. for nutritious alcohol, and for health food has been very popular throughout our country. For over forty years. I have been engaged in the study of ants and the medical application of the ants medicine personally prepared. I have treated more than 10,000 cases of debilitating diseases such as rheumatoid arthritis and hepatitis B. The ants medicine has proved to be of no poison and no side effect either. Nutriologic analyses analyses have disclosed that ants contain a richness of protein. amino acid. trace elements and vitamin. Pharmacological experiments have found that ants have various functions of resisting inflammation. of tranquilizing. of overcoming asthma. and of protecting liver. The curative effect of the ants medicine is stable when used to treat the above-mentioned cases. When taken over a long period of time. it enables middle-aged and old people to become strong and healthy, and promotes the growth of children. Therefore. it is of great immediate and practical significance to make deeper research on ants and to have more extensive application of the ants medicine.

ACOUSTICAL DETECTION OF BORER INSECT IN PLANT PRODUCTS. Youde Qin. Chengti Wei. Yiming Wang (Guangxi agricultural college Naning 530005 Shaogang Huang, bishang Wei (Guangxi Plant Protection General Station. Naning 530022. China)

A new method for detecting borer insects in fruits. grains and other plant products need be developed. Therefore. a sort of quick. portable and practical detecting device may be designed for plant quarantine. This work was carried out from 1986 to 1990. Device was designed. improved and applied in detecting and recording the. feeding and moving sound of fruit flies larvaes in citrus and mango. The freguecys of sound and spike range from 100Hz to 200Hz and 600Hz to 300Hz. respectively. Its detecting accuracy was more than 90%. Besides. the device has also been applied in detecting, comparing and analyzing different sound signals from larvaes of various snot weevils and pyralid moths in other plant products. A large number of experimental data have shown that it is an effective method for plant quarantine.

DISIGN OF TRAPS WITH SEX PHEROMONE AND PESTICIDE. Han-jie Chen, Tong-duo Qiu (Zhengzhou Institute of Pomology, Chinese Academy of Agricultural Sciences, Zhengzhou, Henan Province 450004, China)

Five types of traps were designed for trapping and killing the males of the Oriental fruit moth, *Grapholitha molesta* Busck. By observing the behaviour of the males in the field, the frustum type of traps made of polyethylene board were proved as the best one for male moth landing. The pyrethriode pesticides loaded on the boards appeared some repellent activity at first, but after the frustum traps had exposed in the field for 10 days, the number of the landing males were restored by 80%. The males could be knockdowned when they contacted with the traps even exposed in the field for 80 days. Traps were hung with the density of 140 traps/ha in an isolated orchard with the area of 3 ha. The number of males caught in the experimental traps was reduced by 90-99% and the damage level declined by 60.7% in 50 days' test in comparision with the control. So, the water traps and the stick traps used before could be replaced by the frustum type of traps baited with attractant-insecticide. But for each species of pests the style of the traps could be designed by observing its behaviour.

RICE RESISTANCE TO STEM BORERS (LEPIDOPTERA:PYRALIDAE) IN NORHERN VIETNAM. A.Shcherbakov (All Union Institute for Plant Protection, Podbelsky str.,3, St.-Petersburg, 189620, Russia, USSR).

The rice collections from IRRI (Philippines), VIR (USSR) and Vietnam were examined in 1990-91 in Van-Dien (Norhern Vietnam) for resistance to main pests. More then 20 insect pests, which essentially the rice yield, were revealed during 2-years (4-seasons) of research work. The stem borers were the most harmful pe sts. Sometimes, susceptible cultivars are destroyed almost completely by these pests There are several stem borers species in the North Vietnam, but the yellow stem borer - Scirpophaga (Schinobius) incertulas Walker dominated every year As a result of the evaluation 80 resistant rice cultivars, mainly of local origin, were selected.

SEQUENCE STUDIES ON HONEYBEE mtDNA. R.H. Crozier (Department of Genetics and Human Variation, La Trobe University, Bundoora, Victoria, 3083 AUSTRALIA)

The complete sequence of honey bee mitochondrial DNA is now known for a colony of *Apis mellifera ligustica*. About half of the tRNA genes occur in positions other than for *Drosophila*, but the other genes occupy the same relative positions as in *Drosophila yakuba*. Honey bee mitochondrial DNA appears to have the highest AT content of any mtDNA, and it has diverged significantly more in similarity at both base and (inferred) amino acid levels from their common ancestor than has that of *Drosophila*. The extreme base composition of honey bee mtDNA appears to have had an effect on amino-acid sequences, in that the abundance of amino acids in proteins is associated more with the base composition of the appropriate codon families than with other variables, such as the number of codons per family. Similarity analysis between the cytochrome b genes of *Drosophila* and *Apis* enables a finer resolution of the evolutionary stability of the various regions than seen in other comparisons.

GEOGRAPHIC VARIATION IN *APIS* MITOCHONDRIAL DNA. D. R. Smith (Department of Entomology, University of Kansas, Lawrence, KS 66045 U.S.A.)

Mitochondrial DNA (mtDNA) restriction site polymorphisms were examined in *A. mellifera, cerana, koschevnikovi, florea, andreniformis* and the giant honey bee group (*A. dorsata* in the broad sense). MtDNAs of these species are highly divergent from one another with the exception of the two dwarf bee species, whose mitochondrial genomes are quite similar.

MtDNA restriction site polymorphisms reveal three major lineages of *A. mellifera*: a west European lineage, an east Mediterranean group and an African group. Studies of *A. cerana* reveal three mitochondrial lineages: bees from the Philippines; the Andaman Islands; and a mainland Asian group (including bees from Japan, Malaysia, Thailand, Borneo and southern India). Many *A. cerana* populations still need to be examined. MtDNA polymorphisms in the giant bee group also reveal three groups: *A. d. binghami* from Sulawesi; the giant bees of southern India; and the remaining samples from Borneo, Malaysia, Thailand, Pakistan and the Andaman Islands. Giant bees from the Philippines (*A. d. breviligula*) and the Himalayas (*A. d. laboriosa*) have not yet been examined. There was little intra-species variation in either Indian and Thai *A. florea* or Malaysian and Bornean *A. andreniformis*.

Mitochondrial DNA Dynamics in the Honey Bee (*Apis mellifera* L.). Michael S Meusel
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As mitochondrial DNA (mtDNA) studies to detect paternal leakage had failed, it's mode of inheritance was believed to be strictly maternal.
Only recent investigations of a great number of intra- and interspecific backcrosses in *Drosophila* using a high resolution technique showed paternal influx of mitochondrial genomes and persistent maintenance. Paternal leakage in the honey bee is extremely likely through the occurence of polyspermy and complete penetration in fertilization.
MtDNA polymorphisms of honey bee subspecies were established. Crossings with known differences in mtDNA pattern were carried out and eggs of different stages were screened with a radioactively labelled hybridization probe. Autoradiographs show that significant amounts of paternal mitotypes are present in developmental egg stages up to 96 hours after fertilization. Paternal mtDNA would not be detected at that time if simple dilution with maternal mtDNA during amplification throughout the cell cycles was the only factor. Mitochondrial incompatibility with nuclear background seems to be unlikely as selective force. A maintenance mechanism of paternal mitochondria in the developing egg stages is proposed.

Hybridization between European and Africanized Honey Bees in the Neotropical Yucatan Peninsula

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A population genetic analysis of honey bees of the Mexican neotropical Yucatan peninsula shows that the range expansion of Africanized bees there, has involved extensive introgressive hybridization with European bees. Yucatan honey bee populations now include many colonies with intermediate morphologies. Genotypes of mitochondria have disassociated form historically correlated Africanized or European morphology, producing diverse phenotypic associations. This suggests that the size of resident European populations may be important in explaining previously asymmetrical hybridization. Evidence of natural hybridization is encouraging for the use of genetic management to mitigate the effects of Africanized bees in the United States.

DNA FINGERPRINTING IN HONEYBEES. Alain Blanchetot (Department of Biochemistry, University of Saskatchewan, Saskatoon, Saskatchewan CANADA S7N 0W0)

DNA fingerprinting (DNAfp) is now commonly used to study population genetic structure and analyse pedigree relationships in a wide varicty of organisms including insects. For example, the knowledge of intra-group relatedness, usually determined from protein polymorphism, is an essential component to understand the evolution of the behavioural pattern of eusocial societies. It is generally accepted that Hymenoptera have lower levels of allozyme variation than most insects probably as a result of haplodiploidy. Probes revealing DNAfp profiles was used to examine genetic diversity from social and solitary bee species and study nest mate relationships. It has been found that social Hymenoptera have a lower level of DNAfp detected genetic variation than solitary species. In the social bee species, *Apis mellifera*, direct evidence has been obtained to show that numerous males are involved in the mating process with the mother queen. In contrast, the brood raised in single nests of the solitary bee species *Megachile rotundata* are the offsprings of one singly mated female.

HOMEOBOX GENES IN THE HONEY BEE EMBRYO: R. Fleig (Institute of Zoology, University of Freibug, Germany), U. Walldorf (Biozentrum, University of Basel, Switzerland)

We have isolated several homeobox containing genes from Apis mellifera. Sequence comparison of the cloned homeoboxes and flanking regions as well as "in situ" hybridization and antibody staining allowed us to identify these genes as homologues of the following Drosophila genes: Deformed (Dfd), Sex comb reduced (Scr), Antennapedia (Antp), abdominal A (abd-A), engrailed (en), muscle segment homeobox (msh). Using an antibody against the engrailed protein of Drosophila we were able to stain Apis embryos. We found a close correlation between the presence of the engrailed protein and the intersegmental grooves. With a Dfd antibody additional information was obtained about the segmental organisation of the gnathal region.

STRATEGIES FOR CONSERVATION OF ASIAN HIVE BEE APIS CERANA. L.R. VERMA (International Centre for Integrated Mountain Development, P.O. Box. 3226, Kathmandu, Nepal)

As a result of introduction of allopatric Apis mellifera in the native habitat of Apis cerana, alteration in ecological habitat due to rapid land transformation in the region, indiscriminate use of bio-cides and recurring incidence of European foul brood and Thai sac brood diseases as well harmful traditional methods of honey hunting, there is now a rapid decline in genetic diversity of Asian hive bee, Apis cerana in its native habitat. In order to reverse the above trend, there is a need to adopt strategies for conservation of Apis cerana through development and promotion of beekeeping with this native bee species. Such development strategies should include studies on biology, behaviour and management of Apis cerana in different eco-geographic zones of its native habitat. Major thrust should be on identification of commercially valuable sub-species, their further genetic improvement through classical and molecular techniques and evolving the appropriate apiary management technology based on the ecological and socio-economic conditions of the region. In order to achieve these objectives, a regional beekeeping research and training centre need to be established through the co-ordinated efforts of international funding agencies.

THE DISTRIBUTION, MORPHOLOGICAL VARIATION AND BEHAVIOR OF CHINESE HONEY BEE IN NORTHWESTERN PLATEAU OF SICHUAN PROVINCE. Guanhuang Yang, Qinghai Sun, Shengming Han (Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, Beijing 100093, China)

The morphotogy of workers of Chinese honey bee Apis cerana Fabricius collected from fourteen locations in Aba Planteau, northwestern part of Sichuan Province with elevation of more than 2000 m, in 1987-1989 were examined. The results showed that the morphological variation of the upper reaches area of Daduhe River was less than those of other river. The mean values of the total length of tongue, cubitat index, length and width of 4th tergite were 5.42, 4.28, 9.02, 3.15, 4.23 and 4.57 mm respectively. The more decline in elevation, the morphological character is more similar to the common type of A. cerana. The Aba Type has docile nature, less swarming and absconding, strong poputation (6-8 combs) maintenance and good forage capabilities. A comparison was made between the two types of Chinese honey bee in hillplain area. It was indicated that the Aba colony has better foraging activity and fertility under lower temperature in Spring and Autumn than the common one, while in scorching Summer, it becomes betlicose with poor fertility and high parasitization by waxmoth.

DRONE PRODUCTION OF *APIS CERANA* IN THAILAND.
S. Wongsiri, C. Lekprayoon, S. Pothichot, J. Nakamura (Bee Biology Research Unit, Department of Biology, Chulalongkorn University, Bangkok 10330, Thailand)

The drones of *Apis mellifera* were produced by introduction of *A. mellifera* drone wax foundations for scientific research and breeding purposes. This method is modified to produce drones of *Apis cerana* by introduction of *A. mellifera* beeswax used for worker foundations. The cells of comb foundation are ordinary made of worker *A. mellifera* size (55 cells per square inch both sides) as a sufficient of drone *A. cerana* size (57±2 cells per square inch both sides). In nature *A. cerana* drones are provided by a few small areas of drone cells which the worker bees usually construct along the bottoms and corners of the combs. In this experiment 1-2 sheets of *A. mellifera* worker cell foundations per colony of *A. cerana* were conducted in order to produce drones to advantage in queen rearing yards and to be mass rearing of the parasitic bee mite, *Varroa jacobsoni*. The preference of *V. jacobsoni* for drone broods were found more than worker broods of *A. cerana*. Drone population of *A. cerana* from natural colonies and from drone cell foundations colonies were compared and showed significant difference in each group ($P<0.05$).

Differences in Seasonal Foraging Activities and Foraging Preferences between *Apis mellifera* L. and *A. cerana japonica* Rad. (Hymenoptera: Apidae)
Tetsuo Sakai, Masato Ono, Shin'ichi Kobayashi and Masami Sasaki (*Institute of Honeybee Science, Tamagawa University, Machida, Tokyo 194, Japan*)

Comparative studies on the bionomics, especially the seasonal change in pollen-foraging activities of the European honeybee, *Apis mellifera* L. and the Japanese honeybee, *A. cerana japonica* Radoszkowski were performed. The colonies of honeybees were kept at the same experimental apiary. We describe the differences in the seasonal pollen-foraging pattern of the two species from May 1988 to June 1991. The diversity of pollen-source flowers, size and weight of pollen loads are also compared.

(1)Similar patterns of seasonal foraging activities were observed in both species. From September to October, during which period the average temperature at the experimental apiary dropped suddenly, foraging activity of *A. mellifera* decreased rapidly, but that of *A. cerana japonica* decreased gradually.

(2)The increase in the number of pollen foragers and the beginning of active brood rearing was well synchronized.

(3)A higher diversity of pollen-source flowers was seen in *A. mellifera*, but inter-colony variation in the same species was also seen. Major pollen sources were identified by microscopical analysis of pollen loads.

(4)The size and weight of pollen loads of *A. mellifera* were larger than those of *A. cerana japonica*.

(5)Resistance of *A. cerana japonica* to attack by *Vespa simillima xanthoptera* and infestation by *Varroa jacobsoni* were strongly suggested.

BIOLOGICAL STUDIES ON HONEYBEES IN TAIWAN.
Shu-young Chang (Taiwan Apicultural and Sericultural Experiment Station, 261, Kuan-nan, Kung-Kuan, Miaoli, Taiwan, China)

1. Comparative studies on biology of *Apis cerana* and *A. mellifera*.
2. Comparison of the population and pollen-gatherers of *A. cerana* and *A. mellifera* in orchards.
3. Comparison of the orientation distance of *A. cerana* and *A. mellifera*.
4. The detoxification and susceptibility of *A. cerana* and *A. mellifera* to insecticides.

ELECTRON-MORPHOMETRIC CLASSIFICATION OF THE NATIVE HONEYBEES FROM KOREA.
Y.J. Kwon, E.Y. Huh (Department of Agricultural Biology, College of Agriculture, Kyungpook National University, Taegu 702-701, Republic of Korea)

In the present investigation, some morphometric multivariate analyses were done for both allopatric and sympatric populations of the native honeybee workers (*Apis cerana*) which were selected for 15 different localities in Korea. Comparisons of either different seasonal, local, or sister groups were also conducted to clarify the intraspecific variational range of Korean *Apis cerana*.

COMPARISON OF MORPHOLOGICAL CHARACTERISTICS BETWEEN THE EASTERN HONEYBEE (*APIS CERANA*) AND THE EUROPEAN HONEYBEE (*APIS MELLIFERA*) IN TAIWAN. Kai-Kuang Ho (Dept of Plant Pathology and Entomology, National Taiwan University, Taipei, Taiwan, China)

The Eastern Honeybee (*Apis cerana*) and the European honeybee (*Apis mellifera*) are more important species of honeybee in Taiwan.

Several morphological characteristics were measured to compare the difference between these two species. In general, the European Honeybee was larger and heavier than the eastern Honeybee, but there were some overlaps in body length, wing explanse, length and broad of fore-wing.

FORAGING BEHAVIOR OF STINGLESS BEE ON SOME TROPICAL FRUIT CROP FLOWER. Somnuk Boongird, Saner Buranapawang (Entomology and Zoology Division, Department of Agriculture, Ministry of Agriculture and Cooperatives, Bang-khen, Bangkok, Thailand 10903)

The stingless bees were common insect pollinators distributed in all regions of Thailand. Their foraging behavior on panicle flower of fruit crops had shown positive visit. For durian flower with large size of flower produced pollen which was attractive to stingless bees and only pollen collecting insect could transfer pollen to stigma, but nectar collecting insect could not, because of nectar and pollen were located far distance when compare with body size of insect especially honey bees, and also durian pollen were not attractive to honey bees. Therefore, the stingless bees became specific pollinator of durian flower.

SOME DATA ON MORPHOLOGY OF APIS CERANA FAB. IN VIETNAM. Nguyen Van Niem, Tran Duc Ha (Bee Research Centre;Le Dinh Thai, Hanoi University)

From 1982 to 1988, 32 series of A.cerana worker bee samples collected from different localities in Vietnam were studied according to Alpatov method. The results showed that in A.cerana, the proboces length: 4.74-4.96 mm; the wing length: 7,77-8.28 mm; tergit 3 long: 7.71-8.35 mm; sternit 3 long: 4.13-4.58 mm; wax plate long: 1.68 - 2.04 mm; metatarsus: length: 2.06-2.15 mm. It is clear that the body side of A. cerana reduce from North to South of Vietnam.

Consequently the species of A.cerana in Vietnam can be distinguished into two subspecies A. c. cerana in North Vietnam and A.c.indica in South Vietnam.

COMPARATIVE ASPECTS ON DANCE AND SOUND COMMUNICATION BETWEEN THE ORIENTAL HONEYBEE, *APIS CERANA* AND THE EUROPEAN HONEYBEE, *APIS MELLIFERA*

Masami Sasaki and Yoshihiro Sato (Laboratory of Entomology, Faculty of Agriculture, Tamagawa University, Tokyo, 194 Japan)

Communicative behaviors with dances, sounds and vibrations were compared between *Apis cerana japonica* and *A. mellifera ligstica*. Repertoires common to both species are dances to communicate cites of foraging and nesting and to beg body grooming, and sound of queen piping, etc. While specific ones are seen mainly in *A. cerana*: abdomen-shaking and shimmering related to defense and absconding dance to motivate the re-location of the whole colony members.

Origin, evolution, and adaptive modifications of the communication systems are discussed.

SENSORY BASIS AND EVOLUTION OF THE DANCE LANGUAGE OF HONEYBEES. Wolfgang H. Kirchner (Zoological Institute II, Wuerzburg University, D-8700 Würzburg Germany.

In the dance language, honeybee foragers inform their nestmates of distance and direction of food sources. For a long time it was unclear, how these informations are transmitted in the darkness of the beehive. In the western honeybee, *Apis mellifera*, we recently demonstrated that acoustical signals are emitted by the dancer with high intensity. The bees are able to pick up these sound signals with their antennae. Using a computer-driven "robot bee", it was demonstrated that these sound signals are used to transmit both, distance as well as directional information to the dance attenders. Among the asian bee species, *Apis cerana* produces sounds, which are quite similar to those emitted by *A. mellifera*. In *A. dorsata*, the giant honeybee, no dance sounds had been found in a study by Towne 1985, who concluded that the acoustical signals have evolved after bees started to nest in dark cavities. Recently we discovered that *A. dorsata* in fact produces dance sounds containing distance and directional information like *A. mellifera*, indicating that the acoustical transfer of information has evolved before bees began to nest in dark cavities.

DISTRIBUTION OF FORAGING POPULATION IN HONEYBEE COLONIES. Shu-Young Chang and Feng-Kuo Hsieh, (Taiwan Apicultural and Sericultural Experiment Station, 261, Kuan-Nan, Kung-Kuan, Miaoli, Taiwan, Chinese Taipei)

Monitoring forager population in 24 honeybee (*Apis mellifera*) single-hive colonies showed that the rate of the number of forager to the whole population was 0.18. The rates in the check, general and high royal jelly production colonies were 0.17, 0.18, and 0.19, respectively. Foragers distributed on covers, boards, excluders and combs evenly. In check colonies, foragers aggregated on the side combs of the hive (rate=0.34) where honey presented. In the royal jelly production colonies, a queen-excluder was used to divide to the queen-right and queen-less compartments. Most foragers gathered around the excluder (rate=0.32) and nearby the comb (rate=0.22) in the queen-right compartment, but less on artifical queen-cell frame (rate=0.12). Comparison of forager distribution on various components in the general and high royal jelly production colonies found no significant differences existed.

NATURAL MATING OF INSTRUMENTALLY INSEMINATED QUEEN HONEYBEES

J. Woyke, Bee Division, Agricultural University, Warsaw, Poland

Instrumentally inseminated (II) queens fly out and mate naturally (Woyke 1963). Investigations were conducted on method to prevent natural mating of II queens.

Queens were treated in different manner: 1/ inseminated with $8mm^3$ of semen, 2/ CO_2 + $8mm^3$, 3/ $4mm^3$ + $4mm^3$ and 4/ CO_2 + $8mm^3$ + CO_2. Each group consisted of 12 - 16 queens. Virgins homozygous for the recessive body color gene *cordovan* were inseminated with semen of *cordovan* drones. Mating nuclei with queens were placed into apiary with dominant black drones. Sealed combs with emerging workers were put into isolators in an incubator. Number of emerging *cordovan* and black workers was determined.

Out of queens inseminate instrumentally once, 50% mated naturally. Out of those treated additionally with CO_2, 25% mated. One queen i.e. 8% mated in each of the two remaining groups. Thus additional treatment with CO_2, or additional insemination, decreased the number of queens mating naturally. Within progeny of queens which mated naturally, the % of workers originating from black drones of the apiary was as follows : group 1/ - 30, gr.2/ - 6, gr.3/ - 12, gr 4 - 14. Instrumentally inseminated queens of the three last groups mated additionally naturally, probably with one drone only.

BREEDING AND SELECTION OF THE HIGH-PRODUCTION HYBRIDS OF HONEYBEE-HF213 AND HF414. Xianshu Liu, Wei Shi, Xiaoping Mong, Wei Huo (Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, Beijing 100083, China) Shu Wu, Leyuan Cao, Dahai Wang, Jixiong Yu(Hunan Pnovince Animal Husbandry Bureau, China) Taoxhu Du, Yingshang Zhang, Yonghuei Zheng (Shanxi Province Jinzhong Bee Breeding Farm, China)

The research work for breeding and selection of high-production bee hybrids have been done in the last five years. Queens were gathered and keeped from 8 strains of western bees as breeding material, and 4 strains as the line-ancestries were chosen out of the 8 strains. A, B, C and H inbred lines of western bees were made and maintained with using instrumental insemination through inbreeding mating systems (mother-son back cross, brother-sister cross, etc.) and the coefficient of inbreeding were 0.9045, 0.9355, 0.9296 and 0.5421 respectively. Crossing among lines have been done in accordance with the certain blood relationship structure of bee colony in which the queen was single-cross-hybrid and the worker bees were three-way-cross-hybrids (or back-cross-hybrids). 9 three-way-cross-combinations have been made, and tested and judged on their egg-laying and brood-rearing ability, honey and royal jelly yield, and 2 high-production hybrids of western bees-HF213 and HF414-have been selected. The honey and royal jelly yield of HF213 are about 70% and 10% higher than that of Chinese italian bees respectively, for HF414 are about 20% and 60% higher. Keeping in the lower-middle valley of Yangtze River and North China, HF213 and HF414 displayed obviously superior productivity.

THE TROPHALACTIC FLOW OF PROTEIN IN THE HONEY BEE COLONY.

Karl Crailsheim (Institute of Zoology, Karl-Franzens-Universität, Universitätsplatz 2, A-8010 Graz, Austria)

Colour-coded one-day-old bees (*Apis mellifera L.*) were introduced into 2 colonies on ten frames (about 25 000 bees). Thirty days later, when there were certain numbers of bees of know age in the hive, 100 nurses aged 9 days were removed, injected with ^{14}C-labelled phenylalanine and caged for a few hours. During this period they incorporated about one-third of the injected activity into their hypopharyngeal glands. Introduced back into their colony in the evening for one night, they distributed radioactively labelled jelly.

Young bees received much more of this jelly than middle-aged bees and these more than older bees. The number of bees of these age classes also showed the same dependence on age with regard to the amount of jelly received; the young bees were fed most frequently. Between 10 and 17% of bees whose foraging activity was checked were proven to have been fed. About ten times more of the old L5 larvae were fed as compared to the young L1 larvae and the amount of food was also much greater for the older larvae.

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PROTEIN CONSUMPTION AND DIGESTION OF HONEYBEE DRONES.

M. Szolderits and K. Crailsheim (Institut of Zoology, Karl-Franzens-Universität, Universitätsplatz 2, A-8010 GRAZ, Austria)

The intestinal proteolytic activity of worker honey bees and drones (Apis mellifera L.) of different ages was determined with Hide Powder Azure (Calbiochem) as substrate.

Worker honeybees show their maximum activity on the 8th day, drones between the 3-4th day. The maximum of proteolytic activity in drones is about 2/3 of the maximum of the worker honeybees. Drones of each age category have lower levels of proteolytic activity than worker honey bees of the same age.

The number of pollen in the intestinal tract and the degree of digestion of the pollen grains was examined. Proteolytic degradation is successful in young drones; there are only small numbers of nondigested pollen grains of Castanea sativa and Trifolium repens in the rectum. Protein ingestion - indicated by the amount of pollen in the gastrointestinal tract - depends on age. Similar to the activity of proteolytic enzymes in the midgut, the pollen content is low in young drones, highest in the 3 day old ones and then again low in the oldest drones.

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ENERGY REQUIREMENTS FOR THE FLIGHT OF HONEY BEE QUEENS, DRONES AND WORKERS.

R. Gmeinbauer & K. Crailsheim, Institut für Zoologie, Karl-Franzens-Universität, A-8010 Graz, Austria.

Workers were caught at a feeding place and drones when they left the hive in the early afternoon. Newly emerged queens were caged with some workers for 5 days before being used. Then bees (*Apis mellifera L.*) were fixed in a roundabout and stimulated to fly to exhaustion (humidity 48±8%, temperature 29±1°C). After feeding (10 µl 1.0 - 4.0 M glucose solution) and about 10 minutes' rest they were again stimulated into flight.

Drones and workers show no significant difference in energy requirements (0,5 W/g). These data compare well with NACHTIGALL et al. (J. Comp. Physiol. B 1989, 158:729-737). But the queen's energy requirement (0,3 W/g) differs significantly from the two other castes. The sugar consumption calculated per unit body weight and distance is lowest for queens and highest for workers.

As queens and drones do not provide for themselves during flights under natural conditions as foragers do, the more economical utilisation on the part of the former seem to be a useful adaptation.

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A TECHNIQUE TO COLLECT HONEYBEE SEMEN BY DISSECTION.

Chen, Hong (Department of Entomology, University of Hawaii at Manoa, Honolulu, HI 96822, USA), Zhou, Song (Beijing Academy of Agricultural and Forestry Sciences, Beijing 100081, China)

This presentation deals with research conducted to evaluate the technique of collecting honeybee semen by dissection. Relevant technical operational procedures are presented. The new dissection method for gathering honeybee semen was compared with the old method of extruding. Tests were conducted to compare both methods in terms of: 1) determining sperm viability (quality), 2) quantify sperm level , and 3) to evaluate hive performance after artificial insemination of the queens. Results show that both sperm viability and the amount of sperm extracted for both methods were statistically similar. In addition, hive performance and the reproductive output of the queens inseminated from sperm collected from both methods were comparable. The dissection method has several advantages over the extruding method. Most importantly, sperm can be collected any time of the year. In addition, this method is easy to master and use. This new method will greatly enhance the production and export of high quality artificially inseminated queen honey bees.

STUDIES ON A SET OF TECHNIQUES ON PRODUCING ROYAL JELLY BY WINTER HONEYBEES.

Shenglu Chen, Yong Sun, Xuezhen Ling, Fuliang Hu, Zhanming Fang (Department of Animal Husbandry and Veterinary, Zhejiang Agriculture Univertsity, Zhejiang 310004, China), Jihan Chen (Bureau of livestock, Zhejiang Agricultural department)

This paper discussed the serial techniques by which winter bees (Aphis mellifera) could got high yield royal jelly. The methods were as following: 1. The queens of Zhenong strain A were breeded to get the royal jelly of which the output was very high; 2. The ratio of queens and other members should be gradually raised, the colony was stronly kept through a year, the royal jelly secreting period could be prolonged to seven months; 3. Plastic queen cell strips were used and the colony were fed by artificial pollen-Yufeng Ling; 4. The number of queen cells were depended on the colony. By using these methods, the royal jelly yield per year reached up to 73091g, which were from 17.6kg winter bees, that meant 1kg winter bees yielded 4. 15Kg royal jelly.

SOME CHARACTERISTICS OF *APIS MELLIFERA LIGUSTICA* IN VIETNAM.

Pham Xuan Dung and Tran Xuan Ngan (Bee Research Center, Langha, Dongda, Hanoi, Vietnam)

During 1988-1990 some characteristics of *A. m. ligustica* had been studied: Proboscis 6.58 ± 0.014 mm, color tergit 3:8.50±0.071 (16 indexes of samples of worker bees). The sport rate of Cubital vein a and b and color tergit 4 was rather high (7.08-10.23-9.89%) and other indexes were form 1.60-4.32%.

The weight laying queen was 261.467±1.666 mg (1988) and 266.828±4.203 (1989). The egg laying capacity of queen was 1,320±29.9 and 1,000.8±23.6 (day and night) in the South and North During Autum-Winter seasons.

The rate of death egg was 8.33% on average in 4 years (1987-1990) so the allen of sex gene was 12.

The average honey yield in 1988-1989 was 29.7 and 27.8 kg/colony in the South and North respectively.

During the selection process with *A. m. ligustica* the strains which provide high honey yield but average egg-laying capacity, the other one which give high egg-laying capacity but average honey yield and the intermediate of the two groups were discovered.

POPULATION DYNAMICS OF THE LEAF-CUTTING ANT (Atta laevigata) IN PINE PLANTATIONS (Pinus caribea). Klaus Jaffe, (Univer. Simon Bolivar, Apartado 89000, Caracas 1080, Venezuela)
This work summarizes 10 years of field research on the leaf-cutting ants Atta and Acromyrmex in pine tree plantations in the south-eastern savannas of Venezuela. The main results are: The most important pest is Atta laevigata, which defoliates the pines, causing massive dead of very young pines and eventually killing older trees. A high density of pines at the moment of planting affects the future ant populations negatively, whereas high densities of surviving pines or deep sandy soils correlate positively with nest densities of the ant. High A. laevigata nest densities correlate negatively with wood production in 8 to 9 year old plantations; whereas in plantations which are over 12 years old this correlation disappears, thanks to the selective killing of week trees which reduces competition between pines. The nest densities eventually increase explosively after the canopy has closed after 4 years of plantation. Maximal densities equilibrate at 40-60 nests per ha, although lover levels may be stable due to the fact that adult colonies kill younger ones.

FORAGING DYNAMICS OF SUBTERRANEAN TERMITES. Nan-Yao Su (Ft. Lauderdale Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, Ft. Lauderdale, Florida, USA 33314)

Foraging activity, territory, population sizes of the Formosan subterranean termite, C. formosanus and the eastern subterranean termite, R. flavipes, were monitored in both natural habitats and artificial environments. Despite the relatively mild climates of south Florida, seasonal changes in foraging activity were evident. Colony fusion and budding were observed from field colonies of the Formosan subterranean termite.

POPULATION DYNAMICS OF THE EASTERN SUBTERRANEAN TERMITE. Faith M. Oi (University of Florida, Entomology and Nematology Dept., Box 110620, Gainesville, FL 32611, USA)

Little information exists on the population dynamics of subterranean termites due in large part to their cryptic nature. Consequently, validation of population dynamics models has been problematic. The distributed delay mechanism and type III functional response incorporated into the population dynamics model for the eastern subtarranean termite, *Reticulitetmes flavipes* (Koll.), and a method for validation will be discussed.

GROWTH OF THE FIRE ANT, SOLENOPSIS INVICTA. David F. Williams, Medical and Veterinary Entomology Research Laboratory, ARS-USDA,Gainesville, Florida, U.S.A. 32604

Colony growth studies conducted at constant temperatures indicated that body weights of queens dropped drastically during the first month and then slowly returned to their initial weight after 4 months. By 5 months, queens had increase 1/2 times their initial body weight in all temperatures except 24C and 35C. The greatest increase in colony size was within the first 3 months for all temperatures except 32C which had its greatest increase occurring between 3 and 4 months. By 7 months, overall colony size had increased dramatically at 3 temperatures (27C, 30C, and 32C) with total numbers averaging 151,557 (range 116,768-181,328). Colony queens held at 35C died within 3 months and as expected, colonies maintained at 24C grew the slowest. After one year, colonies held at 27C contained the largest numbers of workers, pupae, and larvae.

Differences in monogyne and polygyne populations of *Solenopsis invicta* Buren.

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Both monogyne and polygyne populations of *Solenopsis invicta* Buren (Hymenoptera: Formicidae) exist in the southeast United States. The polygyne appears to be of recent occurrence and is slowly spreading at the expense of the monogyne population. The behavior and characteristics of these two populations differ in a number of respects. These include worker size, density of mounds, aggressiveness of workers, isozyme and hydrocarbon patterns. These differences are described and the impact of the different densities of these ants on the ecosystem will be discussed.

MODELING ANT POPULATIONS. D.G. Haile, G.A. Mount (Medical and Veterinary Entomology Research Laboratory, Gainesville, Florida, USA)

A model, IFASIM, was developed for computer simulation of the population dynamics of the imported fire ant, *Solenopsis invicta*. The model simulates the effects of major environmental variables on growth of this social insect in various types of habitat. The life cycle of *S. invicta* was incremented in the model into weekly time steps. The model includes temperature-dependent development rates for eggs, larvae and pupae; the influence of habitat type, temperature and precipitation on survival rates of all life stages; the effect of temperature and worker ant density-dependence on feeding rates; density-dependent survival of colony-founding queens; the effect of temperature and fourth instar larvae density on fecundity; the production of alates influenced by temperature and season; and the effects of temperature and precipitation on mating flights. The model software is written in Microsoft Professional Basic for interactive operation on IBM or compatible microcomputers.

A STUDY ON POPULATION DYNAMICS AND REPRODUCTION REGULATITY OF CAMPONOTUS JAPONICUS MAYR (HYMENOPTERA: FORMICIDAE). Chang-tu Wang, Jian Wu (The Forest Research Institute, Chinese Academy of Forestry, Beijing 100091, China)

The wide spread Chinese ant Camponotus japonocus nests under ground, with an average population of 249 eggs, 592 tarvae, 306 pupae, 1298 workers and 1 dealate femate according to investigation of 13 nests from Aprit to September. A single femate to establish a new colony will need 37 days for the first group of workers to hatch. The queen wilt tay an average of 12.5 eggs per day. It is estimated that one queen can lay 1250 eggs per year. The major, media, and minor workers can tay eggs when the queen is absent. Major worker has a stronger fecundity than the media and minor ones.

Comparative Ethology of Social Organization in Ants

Pierre Jaisson and Dominique Fresneau, Ethologie Expérimentale et Comparée, URA CNRS n°667. Université Paris-Nord, 93430 Villetaneuse, France.

Researches developed during the last ten years on social organisation in ant species of a particular evolutive interest allow to intent to present a comparative assessment. Considering principally *Nothomyrmeciinae*, *Myrmeciinae*, *Ponerinae* and some species belonging to socially advanced subfamilies, differences appear at four levels which seem to be critical from an evolutionary point of view:

* Task distribution between behavioural subcastes,
* Mean percentage of worker immobility within the nest in the global time budget of the society,
* Mean percentage of social interactions between workers within the nest,
* Mean distance to the nearest neighbour within the nest.

If general relationships seem to emerge between phylogeny and complexity degree of social organization it is improbable that such ethological information became a taxonomic tool.

ABOUT POLYETHISM, AGE AND SOCIAL REGULATION IN ANTS

Bruno Corbara (Laboratoire d'Ethologie et Sociobiologie, Université Paris XIII, F-93430 Villetaneuse, France and Laboratory of Applied Entomology and Nematology, Faculty of Agriculture, Nagoya University, Nagoya, Japan).

We have studied the social organization (in terms of division of labour) of the Ponerine ant *Ectatomma ruidum* in three different situations : (1) 3 young societies, from the foundation stage to the 10-workers stage, (2) a mature society, during 9 six-days periods spread over 5 months, (3) artificial queenless groups of same-age callow workers. In the three cases, all the workers, which were individually labelled, were of known age. Behavioural data show, at the individual level (individual ethograms) as well as at the level of functionnal groups (determined by means of factorial and hierarchical cluster analysis) that the well-known phenomenon of "age polyethism" underlies a much more complex reality than it is generally considered. In the case of the mature society, at the individual level, even if the great majority of the workers are at first mostly oriented towards the brood and later implied in guarding and foraging, there is a very high variability in the durations of the temporal behavioural specializations. Consequently, same-aged workers may show very different behavioural profiles. Nevertheless, if we consider the functionnal groups, a classical scheme of age-polyethism is respected. In the first stages of the young societies as well as in the experimental situation where same-aged callows groups were considered, very young workers can be foragers. Accordingly, we hypothetize that age polyethism can be viewed as an observable emanation of the permanent social regulation occuring in the society, this latter being due to the changes in the social environment.

DAILY RHYTHM AND SEASONAL ACTIVITY OF THE WEAVER ANT, POLYRHACHIS VICINA. Yi Chen, Jue Tang (Department of Ptant Protection, Zhejiang Agricutturat University, Hangzhou, Zhejiang 310029, China)

The weaver ant, Polyrhachis vicina is a predator as wetl as a promising Chinese medicine which has potential to cure ittness such as arthritis and pneumonia. The colony overwintered as queens, males, workers, eggs and larvae. The eggs and tarvae in winter showed tittte growth until the foltow spring, when the weather became warm and then devetopment proceeded rapidty. Outing activity seldom proceeded in winter, and colony mainty lived on the nutrient accumutated in the bodies of workers and larvae. Seasonat dynamics of the colony appeared two peaks in May and in September. Activity proceeded in the daytime. Daily rhythm of activity varied among seasons. Light switches on outing activity of workers. Temperature is a major factor affecting the activity. Activity reached a peak at noon in Aprit, two peaks from July to October because of the high temperature teading to decreasing activity at noon. Activity peaks didn't appear clearty in May, June and November. While returning to the nest, 47.7% of workers carried food in their crops with the head width of 1.45-1.80mm, 6.8% of workers carried food and nesting materials between their mandibles with the head width of 1.40-1.80, 45.6% of workers carried nothing with the head width of 1.35-1.75mm.

FAUNA AND BIOLOGY OF TERMITES IN VIET-NAM. N.V. Beljaeva.(Biological faculty, Moscow Lomonosov University, Moscow, 119899 Russia)

A survey was carried out during 1989-1991 in southern Viet-nam. A study was included the following aspects: the termite fauna, population dynamics and seasonal abundance, foraging activity, peculiarities of biology of certain species, nest types and nest structures, role of termites in utilization of leaf fall. The termites were collected in different landscapes, including plains, hills and mountains, where the lots of primary and secondary forest were inspected. Also the termite fauna of secondary savannas and coastal dunes were determined. About 70 species of termites belonging to 15 genera and 3 families were identified.

FAUNA AND PHYIOGENY OF TERMITE (ISOPTERA) OF YUNNAN. Shi-mo Zhu, Bing Yang (Kunming Institute of Zoology, Academia Sinica, Kunming, 650107, China)

Yunnan region was made up by two continents. So that the climate and geography of Yunnan are much complicated. It can be divide into 7 climatic zones. Many evidenees show that the termite originated between Permian and Triassic in Yunnan, and divided into three different eco-geographical types: 1. Humid and torrid type: such as Macrotermitinae and Nasutitermitinae; 2. Wide ditributed type: such as the genus Odentotermes of Termitidae; 3. High habitating type: such as the genus Reticulitermes of Rhinotermitidae.

ORIGINS OF MANDIBULAR AND OTHER STRUCTURES IN THE NASUTITERMITINAE, AND A DISCUSSION OF THE ORIGINS OF THE TERMITIDAE.

L.R.Miller
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The pattern of imago/worker mandibular dentition in some fully nasute genera of the Nasutitermitinae is clearly more primitive than that of *Syntermes* or any other mandibulate genus. The polarity of a series of characters, including mandibular dentition, is discussed in order to clarify relationships within the Nasutitermitinae, between the subfamilies of the Termitidae, and between the Termitidae and the lower families. The precise origins of the Nasutitermitinae and the Termitinae are unclear but the primitive mandibulate Nasutitermitinae have characters possibly homologous with those of some Macrotermitinae, which in turn are similar to the Hodotermitidae. It appears likely that the Termitidae is derived independently from the Termopsid/Hodotermitid line, rather than directly from the Rhinotermitidae.

SEASONAL VARIATION IN CUTICULAR HYDROCARBON PROFILES OF *COPTOTERMES FORMOSANUS* SHIRAKI (ISOPTERA: RHINOTERMITIDAE) IN HAWAII. J. Kenneth Grace, (Department of Entomology, 3050 Maile Way, University of Hawaii, Honolulu, HI 96822-2271, USA), Michael I. Haverty (Pacific Southwest Research Station, USDA Forest Service, P.O. Box 254, Berkeley, CA 94701, USA)

The Formosan subterranean termite is broadly distributed on the island of Oahu, Hawaii. During the past 1.5 years, we have made monthly collections of all castes from seven *C. formosanus* colonies located in different areas of Oahu. Forty-five individual or isomeric mixtures of cuticular hydrocarbons were identified by GC/MS, including several unusual dimethylalkanes with a methylene group separating the methyl groups, such as 13,15-dimeC29 and 15,17-dimeC31. Many of these components occur in very small amounts (less than 0.5% of the total hydrocarbon) and were not recognized in earlier studies with this species. The average hydrocarbon profiles of termite workers and soldiers were not drastically different, and the variability in relative proportions of the more abundant hydrocarbons was quite low among the seven colonies. Variability in relative hydrocarbon proportions was also low from month to month, with the exception of C-39 and C-41 components. These late-eluting components were present in significant proportions in the Fall and Winter, but decreased drastically in Spring 1991.

TAXONOMY AND CUTICULAR HYDROCARBONS OF AUSTRALIAN *COPTOTERMES* by J.A.L. Watson, W.V. Brown and M.J. Lacey, CSIRO Division of Entomology, GPO Box 1700, Canberra ACT 2601, Australia

In economic terms *Coptotermes* is Australia's most important genus of termites; but its taxonomy, which is based on morphological criteria, is inadequate and erroneous. Studies of the chemistry of cuticular hydrocarbons of workers have shown that:

1. Two biologically very distinct but morphologically similar sympatric south-eastern populations, hitherto placed as *C. lacteus*, have qualitatively very different cuticular hydrocarbons, and constitute distinct species.
2. Mound-building populations of *C. acinaciformis* from northern Australia have cuticular hydrocarbons qualitatively dissimilar from those of allegedly conspecific southern Australian termites, including tree-nesting south-eastern and tree-nesting and mound-building south-western populations. They also appear to constitute distinct species.
3. The cuticular hydrocarbons of mound-building *C. lacteus* from south-eastern Australia are very closely similar to those of the morphologically and biologically distinct south-western species *C. michaelseni*. Thus similar hydrocarbon profiles need not indicate that populations are conspecific.
4. *Coptotermes frenchi* includes two species, a tree-nesting south-eastern population of some economic importance and an economically benign inland south-eastern to south-western mound-building form. Their cuticular hydrocarbons differ qualitatively as well as quantitatively. At least some of the subterranean south-western populations hitherto identified as *C. frenchi* appear to be *C. michaelseni*, to judge from their cuticular hydrocarbons.

Multivariate analyses of morphometric data are in progress, to help resolve these problems, along the lines of those already undertaken on Australian *Heterotermes* (Watson *et al.* 1988).

ALLOZYMIC VARIATION AND REGIONAL DIFFERENTIATION IN A PRIMITIVE TERMITE HODOTERMOPSIS IN JAPAN AND CHINA Tadao Matsumoto, Jiasi Wang(Department of Biology, College of Arts & Science, The university of Tokyo, Komaba, Meguro-ku, Tokyo 153, Japan)

The genus Hodotermopsis is regarded as one of the most primitive termite genera, classified into four species now. In the present study, first, incipient colony was investigated occurs in mature colony or not, allozyme analysis was done. Genotype frequencies were compared between incipient and mature colonies in the Yakushima Island. Further, allozyme patterns were examined on 8 populations, from the Nansei Archiperago, Japan and China. Nei's genetic distanes were calculated among them. The genotype frequencies showed significant difference between mature and incipient colony. This supports the possibility of inbreeding. According to the genetic distance, 8 populations were classified into 3 groups. One of which contains all the Japanese populations, others Chinese ones. This result corresponds to the present classification, but distance value among groups confined to inter-subspecific level. And distances among Japanese populations does not reflect presumed geographical history.

THE MODIFIED THIRD ANTENNAL SEGMENT OF DRY -WOOD TERMITE SOLDIERS, STRUCTURE AND FUNCTION(ISOPTERA,KALOTERMITIDAE).
BAO LIAN LU (Institute of Zoology, Academia Sinica,Beijing, China). W.L.NUTTING (Department of Entomology,University of Arizona,Tucson, AZ 85721, U.S.A.

In 12 genera of Kalotermitids, in all or part of the species, the soldier caste has the 3rd antennal segment modified and larger than the others. Soldiers of 3 species were chosen from the Arizona Sonoran Desert for comparative study, Paraneotermes simplicicornis (Ps) with simple, unmodified antennae, Pterotermes occidentis(Po) with the 3rd segment moderately modified, and Marginitermes hubbardi (Mh) with the 3rd segment clavate and nearly as long as the rest of the antenna. Heads of freshly killed soldiers were removed processed by standard procedures for study by SEM & TEM . As suspected , the enlarged segment provides more surface area for a large array of sense organs not found on the unmodified segments. These are 5 major types sense organs. Based on extensive field studies and limited laboratory observations we believe that its function can be interpreted in the context of the behavioral ecology of various genera and species. Ps lives in hard woods with few external exits to be guarded,whereas Po and Mh inhabit trunks and branchs of softer woods, with many exits and "kick holes". Indeed Po sometimes inhabits abandoned larval beetle galleries with many large external holes to be guarded.

TERMITE COMMUNITY IN THE TROPICAL RAIN FOREST OF AUSTRALIA. Takuya Abe (Center for Ecological esearch, Kyoto University, Shimosakamoto, Otsu,520-01 Japan)

Termite fuana in the tropical rain forest of Massey Creek located near Ravenshoe in the northern Queensland of Australia consisted of 6 species (1 species of Termopsidae, 2 species ofKalotermitidae, 3 species of Rhinotermitidae and 1 species of Nasutitermitinae of Termitidae) and was characterized by the paucity of species and the dominancy of the lower termites. All species nested in and consumed wood. Fauna, density, feeding habits and life type composition in the tropical rain forest of Australia were quite different from those in the tropical rain forests of Africa, Asia and America. For example, in the tropical rain forest of Malaysia, 52 species occurs in 1-ha plot, and many of them are soil feeders. The termite life in the rain forest of Australia is one-piece type, while that in the rain forests of other continents is separate type (nesting site and feeding site are different).

AN INVESTIGATION ON THE TERMITE FAUNA OF IRAN.
Morteza Esmaeili and R. Ghayurfar (Plant Protection Dpt., College of Agriculture of Tehran University, Karaj 31584 Iran)

During three years investigations, 7 species were studied, *viz. Miciocerotermes diversus* Silvester, *M. gabrielis* Winder, *M. buettikeri* Hagen, *Amitermes vilis* Hagen, *A. stephensoni* Haris, *Anacanthotermes vagams* Hagen and *A. turkestanicus* (?).

Their geographical distribution and economical importance will be discussed.

ECOLOGY OF THE FOREST TERMITE *COPTOTERMES LACTEUS*.
D.M. Ewart & J.R.J. French (CSIRO, Division of Forest Products, Private Bag 10, Clayton, Vic. 3168, Australia).

Coptotermes lacteus is a eucalypti forest termite restricted to the eastern seaboard of continental Australia. It preferentially nests in the base of large trees, and regularly constructs mounds, usually when the colony outgrows its nesting timber. Nests are constructed of mixtures of soil and wood products, with a hard outer clay well and a complex, spongy interior of mostly faecal material. The termites tightly control the nest's environment as is exemplified in their fine thermoregulation of the brood area. Through the twin roles of detrivores and channelizers of timber and soil, *C. lacteus* populations are threatened by current forestry practices which works against both the termites and the ecosystem services they supply.

THE EFFECTS OF SOME CLIMATIC AND EDAPHIC CONDITIONS ON TERMITE ABUNDANCE IN TROPICAL AUSTRALIA. J.A. Holt (CSIRO Division of Soils, Davies Laboratory, PMB PO Aitkenvale, Queensland, Australia 4814)

The factors influencing animal distributions are complex and varied, and for many taxa remain obscure. At the present time, ecologists are unable to satisfactorily explain the distribution and abundance of termites. Although a few authors have referred to the effects of soils and climate on termite distributions, much of the evidence is anecdotal and little progress has been made towards developing a better understanding of the factors influencing termite distributions.

The abundance of detritiverous, mound-building termites and certain aspects of the climate, soils and vegetation at 15 sites in tropical Australia have been examined. No relationship between termite mound density and the texture or particle-size characteristics of surface soil horizons, plant available phosphorous or rainfall was found. Microbial biomass carbon levels of the surface soil were found to have a strong negative relationship with termite mound numbers.

The negative interaction between the soil microbial population and termites may be due to the limiting effect of the organic matter processing capacity of the soil microbial population on the success of termites in occupying the decomposer niche in any particular area.. Microbial biomass may therefore be a major factor influencing termite abundance in tropical Australian landscapes and elsewhere.

GRASS CONSUMPTION AND PREFERENCE IN THE HARVESTER TERMITE *TRINERVITERMES TRINERVOIDES* (SJöSTEDT) (ISOPTERA: TERMITIDAE). R.A. Adam, T.C. de K. van der Linde & M.C. van der Westhuizen. (Dept. Zoology and Entomology, University of the OFS, P.O. Box 339, Bloemfontein 9300, Republic of SA).

Trinerviternes trinervoides is a common mound building termite in South Africa. It has been suggested that this termite can remove between 20% and 60% of the standing grass (Coaton, 1951). Grass consumption and food preference was determined respectively in the veld and laboratory.

There is a significant ($t=18,175$; $P<0,05$) correlation between consumption and mound height. *T. trinervoides* removes grass at the rate of 234,1 kg/ha/year. Preference experiments revealed that *T. trinervoides* prefers standing grass to grass lying on the ground. They also preferred grass litter to any species of fresh dead grass offered.

Litter production is estimated at 1600 kg/ha/year. Consequently it is doubtful whether *T. trinervoides* is of significant economic importance in South Africa.

BEHAVIOR OF FORMOSAN TERMITES IN LOUISIANA. Gregg Henderson (Department of Entomology, Louisiana State University, Baton Rouge, Louisiana 70803-1710, USA

Coptotermes formosanus Shiraki is slowly spreading into new areas of Louisiana. It has taken almost 30 yrs for this species to get from New Orleans to Baton Rouge, 65 miles away. They appear to travel most successfully along waterways. A reduced level of interspecific competition is the suspected reason for this travel route. Trap catches during flight seasons indicate that their numbers are increasing rapidly in areas where they are well established. Interestingly, factors intrinsic to the colony dictate the flight pattern once it has started. Research into understanding the dispersal behavior and foraging behavior of this species is discussed.

TERRITORIALITY OF SONORAN DESERT SUBTERRANEAN TERMITES. Susan C. Jones and Joe K. Mauldin (Southern Forest Experiment Station, P.O. Box 2008GMF, Gulfport, Mississippi 39505, USA)

Foraging behavior of Sonoran Desert subterranean termites was studied in plots consisting of rolls of toilet paper and corrugated paper located in southern Arizona, USA. Intercolony aggression was observed at the boundary of two Heterotermes aureus (Rhinotermitidae) colonies. Rows of dead termites locked in combat were observed within the roll, with many additional dead termites usually in the soil beneath the roll. After the initial observations of intercolony conflict, H. aureus was not observed at the roll until 10 months later, when dead termites were once again present in large numbers. Discrete H. aureus territories may be maintained by ongoing intercolony aggression. In addition, interspecific aggression between H. aureus and Gnathamitermes perplexus (Termitidae) may influence the temporal and spatial distribution of these two subterranean termites.

Section VII: Social Insects and Apiculture

THE SIGNIFICANCE OF FUNGUS-DECAYED WOOD FOR THE BIOLOGY OF *Coptotermes lacteus* (Frogatt). GICHORA, Mercy (Kenya Forestry Research Institute, P.O. Box 20412, Nairobi, Kenya); Michael Lenz, (CSIRO Division of Entomology, P.O. Box 1700, Canberra, ACT 2601, Australia).

Coptotermes lacteus is reported to prefer feeding on decayed over sound wood. Previous research involved only a limited choice of fungi and levels of decay of wood. The response of this termite species given a wider range of wood-decay situations remained to be studied and the significance of decayed wood for its biology underscored.

This study confirmed termite preferences for decayed wood following exposure to certain species of fungi. Several factor interactions came into play in the determination of feeding and survival responses as well as colony development. Intra-specific differences in these responses were found both for the tree and termite species under investigation. An analysis of the nitrogen content of wood in various decay situations was carried out, and the possibility that its variation was a likely basis for the preferences displayed was raised.

LONG-TERM IMPACT OF ORPHANING FIELD COLONIES OF *COPTOTERMES LACTEUS* (FROGGATT) (ISOPTERA, RHINOTERMITIDAE). Michael Lenz & Silvano Runko (CSIRO, Division of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia).

Out of a set of colonies of the mound-building *Coptotermes lacteus* from a site in SE Australia, randomly chosen sample colonies were examined on one occasion each 3, 6, 12, 18, 24 or 30 months after removal of the primary queen. Colonies contained either a small number (< 5) of female replacement reproductive (neotenics) which increased in their biomass from 37 mg at 3 months after orphaning to 125 mg after 24 months, or nests were headed by a larger number of neotenics (max. 27). In the latter case neotenic showed limited physogastry with no significant change in biomass (range 38-52 mg.) between 6 and 30 months after orphaning. After 30 months the combined biomass of all functional female neotenic sometimes approached or even exceeded that of the original primary, but was below that in most cases.

Orphaned colonies no longer produced nymphs in a fixed seasonal cycle, but all year round instead. Even 3 months following orphaning, first stage nymphs were present at a time of year when primary-headed colonies do not contain this stage. Almost all of the nymphs, even 2.5 years after orphaning, were males (the sex ratio is normally fairly balanced). Not all of the many nymphs in orphaned colonies develop into alates. After 2.5 years, a percentage of the nymphs had undergone regressive development and was thus maintained in the workforce. Events in the experimental colonies were mirrored in a recently discovered colony orphaned by natural causes.

INTER-INDIVIDUAL BEHAVIORS IN RETICULITERMES SPERATUS (KOLBE) (ISOPTERA, RHINOTERMITIDAE). R. Ivata, T. Yoshikawa & F. Yamada (Dept. of Forestry, Coll. of Agr. & Vet. Med., Nihon University, Tokyo 154, Japan)

Termites' inter-individual behaviors, as ascribed to the sociality, have scarcely been observed in detail, except for those on Coptotermes formosanus by Ivata et al. (1987). We observed those behaviors in Reticulitermes speratus speratus (Kolbe), checking all the combinations of the castes and developmental stages, such as egg, young larva (unable to walk), senior larva (able to walk), worker (including pseudergate), soldier, young nymph, old nymph, allate (pre-swarming), deallate adult (remaining in the colony) and young queen. Individuals from reared colony were accommodated in a petri-dish with a wet circle filter paper on its bottom, and were observed by binocular microscope. Also, we sprayed a dye-containing aerosol directly onto them, stained their body surface, and observed the dyestuff's subsequent behavior through termites' groomings.

Groomings was observed most active in workers, followed by deallate adults and old nymphs, with senior larvae also observed doing them each other. Reticulitermes differed from Coptotermes in that one individual can groom the other and, at the same time, be groomed by the third though rarely. A touching behavior, using mouth parts, was observed mostly in workers, but not toward soldiers and young queen. It was thought to be an action promoting the trophallaxis. Stomodeal trophallaxes were observed most frequent between workers, between worker and young queen, between deallate adults, and between worker and larva. Proctodeal trophallaxes were observed most frequent between workers, from senior larva to worker, and from young queen to worker. Behaviors donating fragments of colony associate' carcass by mouth parts to the others took place only in workers toward all the castes except for soldier. Stain on the body surface by the aerosol spray was observed to behave similarly to that in Coptotermes, which was reported before.

THE EFFECT OF Anacanthotermes ahngerianus Jacobs. (Hodotermitidae) ON SOIL AND PLANTS. D.P.Zhuzhikov. (Biological faculty, Moscow Lomonosow University, Moscow, 119899 RUSSIA).

The developed colony of termites has main nest and several additional nests disposed near the former. Foraging underground passages stretch for tens of metres. Water-bearing passages reach groundwater level. The dry plant particles as nutrient suply are picked by workers on whole foraging area and brought into the nest. Many chambers of old nests are filled with termite feces. The mound and overground passages are made of clay, which is extracted by termites from deep soil horizons. Termites keep up the high level of relative moisture in the nest by means of transfered subsoil water. Thus, during life cycle of colony take place two substance flows: centripetal flow of plant remains and vertical flow of mineral substances. The feces are the source of accumulation of nutrient elements, humus-clays and trace substances. High mineral level of underground water promotes superfluous accumulation of different salt including sodium-containing substances in the mound. As a result of that, the mound has no vegetation on its surface. Also the growth is suppressed probably by phenolic compounds accumulated in termite feces. The water and wind erosion disperse annually salic horizon of mound on the terrain. The cumulative effect of termites on the soil fertility is conditioned by the ratio of positive and negative processes.

COMPARATIVE PHYSIOLOGY OF INSECT ACETATE TRANSPORT SYSTEMS. A. Messer and T. Hoshi. (University of Shizuoka, Yada 52-1, Shizuoka 422 JAPAN.

We investigated production and transport of acetate and other volatile fatty acids in insects. Microscopic studies revealed a variety of spines in the hindgut of *Panesthia angustipennis*. Bacterial associations found on the surface of the spines ranged from rods oriented horizontally along the spine shafts to dense, globular bacterial aggregations at the apex. The fermentation products acetate and lactate were detected at 8-16 mM concentrations in both the foregut and the hindgut . Acetate transport from the lumen to the hemolymph side of everted *Periplaneta americana* recta was active and electrogenic. The pH- and concentration-dependent responses included: i) at pH 7.0 an initial, rapid increase (seconds) in mucosal positivity; and ii) at pH 5.5 a gradual increase (~15 min) in mucosal negativity. At pH 7.0 there is a linear increase in potential difference to 42 mV at 64 mM. Intracellular recordings made in roach Ringer's solution at pH 7.0 showed that cells hyperpolarize upon addition of acetate, and demonstrated that entry of acetate is metabolically dependent. These results indicate that insects have evolved a specialized transport system for transport of nutritionally important organic acids.

NITROGEN FIXATION BY TERMITE SYMBIONTS. Deborah A. Waller (Biology Department, Old Dominion Univ., Norfolk, VA 23529 USA)

Many termite species harbor hindgut bacteria that fix atmospheric nitrogen. Nitrogen fixation may be essential to termite growth and vitality and may represent a substantial source of nitrogen in terrestrial habitats, but little is known of the dynamics of nitrogenase activity in termite hindguts. In this study, the acetylene-reduction technique was used to evaluate rates of nitrogen fixation in termites under different environmental conditions including temperature and diet quality. One species of bacteria from Reticulitermes' hindgut did not fix nitrogen in isolation, but instead augmented rates of nitrogen fixation in other bacteria.

CHEMICAL POLYMORPHISM IN TERMITEOF THE GENUS *RETICULITERMES*

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Cuticular lipids are used to separate Termite species. Each species has a particular mixture of 20 to 40 hydrocarbons consisting of n-alkanes, mono- and dimethyl-alkanes, monoenes, dienes and trienes. These variations determine aggressive behavior between workers in european and american *Reticulitermes*.

Defensive compounds (αpinene, βpinene, limonene, γcadinene, germacrene, geranyl-linalool...) synthesized by soldiers are also different between species. In SW United States a strong polymorphism between sympatric colonies in *R. flavipes* was detected in terms of both the hydrocarbons of the workers and soldiers and the defensive secretions of the soldiers. The 6 phenotypes of the cuticular hydrocarbons and defensive compounds are linked in each colony.

Within a species cuticular hydrocarbons may vary quantitatively. Multivariate analysis of european and american *Reticulitermes* have shown that each caste (worker, soldier, nymph, alate, neotenic...) is defined by a particular chemical pattern. In *R. santonensis*, soldiers are defined by monoenes and dienes variations, nymphs by n-alkanes, neotenics by monomethylalkanes, alates by a mixture of methyl alkane and alkenes. Workers, in fact old larvae, are in a central position.

TERMITES AS PESTS OF AGRICULTURAL CROPS IN PAKISTAN. Muhammad Saeed Akhtar (Dept. of Zoology, University of the Punjab, Q. A. Campus, Lahore, Pakistan).

Termites fauna of Pakistan consists of 50 species of termites. Of these, nine species of termites, i.e. *Odontotermes assmuthi Holmgren, O. guptai* Roonwal and Bose, *O. gurdaspurensis* H. & H., *O. horai* Roonwal and Chhotani, *Microtermes mycophagus* (Desneux), *M. obesi* Holmgren, *M. unicolor* Snyder, *Eremotermes paradoxalis* Holmfren and *Angulitermes dehraensis* (Gardner), were recorded as pests of agricultural crops in Pakistan. Relationship of foraging termite population density (in agricultural fields) to percent damage and different environmental factors is discussed. vertical distribution of termites in agricultural fields revealed that there was higher termites foraging activity in upper 20 cm layer of soil as compared to 40 or 60 cm deep soil layer.

THE TERMITES ON SOUTHERN PART OF SHAANXI PROVINCE AND THE DESCRIPTION OF THE NEW SPECIES. Ying-jun Zhang (Department of Biology, Northwestern University, Xi'an 710069, China)

This paper records 11 species of termites, which are distributed between the north of the Daba mountains and the south of the Qinling mountains in the Shaanxi province, China. Among them 2 are described as new species in science. The descriptions are summarized as following.

Odontotermes ziymmariaed sp. nov. Soldier: Between the prozona and metazona of pronotum no hollow on both sides; Soldier and worker: The body are larger than those of the *O. louyangensis* and *O. formosenus*. Type locality: Ziyang county, alt. 320 M, 32.5 ° N., 198.5 ° E., Collected by Xing, August 17, 1990.

Nasutitermes bashanensis sp. nov. Soldier: dimorphic, its size of major and minor soldier larger, apical tooth of mandibles larger than those of the *N. shangchengensis* Wang and *N. obtusimandibulus* Li, the antennae 13–14 articles. Type locality: Zhenping county, alt. 800 M, 109.5 ° E., 32.3 ° N., collected by Tian, May 20, 1989.

TERMITE ACTIVITY AS RELATED TO SOIL MANAGEMENT IN SEMI-ARID ALFISOL. M.Vikram Reddy, V.P.Kiran Kumar (Environmental Biology Laboratory, Department of Zoology, Kakatiya University, Warangal 506009,A.P.,India), A.L.Cogle, D.F.Yule and P.J.George (ICRISAT, Patancheru 502324, A.P., India)

Termite activity in terms their feeding small pieces (6x6x3 cm) of Eucalyptus wood and toilet rolls across different soil management treatments which included tillage with amendments of farmyard manure or rice straw cover and perennial pastures, was studied during September 1991 to January 1992 which is normally the peak period of surface feeding in subterranean termites. Two species of termites viz., **Odonototerms obesus** (Rambur and **Microterms obesi** (Holmgren) were recorded, the former being the major (or derminant). Their activity was greater in annual crop plots (maize, **Zea maize** L.) compared to perennial crop plots. The activity was minimum in zero tillage with the annual crop and bare surface as well as in the nearby undistrubed grassland area while it was higher in deep tillage with the annual crop. Among the perennial crop plots, it was higher in zero tillage with **Stylo hamata.** However, there was little significant difference in termite activity in between treatments of annual crop as well as that of perennial crop plots. Across the season, the termite activity was recorded maximum in January 1992 as the temperate decreased to a low ebb.

Distribution of termiticides in Soils. Shripat T. Kamble and Robert W. Davis. Environmental Programs, Univ. of Nebraska, Lincoln, NE 68583-0818, USA.

The research was undertaken to determine the horizontal and vertical distribution of chlorpyrifos (Dursban® TC) in various soils. Of the 38 experiment units (each 1.2 X 1.2 X 0.6 m), 19 were filled loamy sand and the remaining 19 with silty clay loam soils. All units were capped with 7.6 cm concrete slab and treated with Dursban TC 1% with a B&G subslab injector. Insecticide quantities (4.56 and 10.64 L), each applied under 138, 345 and 551 kPa. Chlorpyrifos from soil samples was extracted and analyzed with a gas chromatography. The data indicated that >500 μg of chlorpyrifos per gram of soil was detected in silty clay loam at 2.5 cm depth and up to 53 cm horizontally ant any quantities and pressures. However, in a loamy sand, >500 μg of chlorpyrifos per gram of soil was only found at 2.5 cm depth and up to 61 cm horizontally when applied at 10.64 L per hole. According to our data, holes spaced at 37 to 45 cm during subslab treatment may provide continuous chlorpyrifos barrier in soil for controlling subterranean termites.

FIELD TESTING OF NEWER INSECTICIDES AS TERMITICIDES UNDER INDIAN CONDITIONS. R. V. Varma, (Division of Entomology, Kerala Forest Research Institute, Peechi - 680 63, Kerala, India)

In India, control of termites in agricultural crops, forest plantations, buildings etc., are all based on application of persistent organochlorine insecticides. In forestry, aldrin or a similar insecticide is being used against termites attacking eucalypts. Research on the use of less persistent insecticides for control of termites is only in the beginning. Some of the data available based on laboratory studies are not practicable under field conditions. Studies conducted in KFRI, using some organophosphate and synthetic pyrethroid insecticides have not yielded consistent results. Detailed studies under tropical soil conditions are required on dosage rates and field persistence of some of the promising alternative termiticides. The need for technical cooperation from developed countries in research on replacement of organochlorine inseticides with alternative chemicals is stressed.

LONGEVITY OF SOIL PESTICIDES FOR *COPTOTERMES FORMOSANUS* SHIRAKI (ISOPTERA: RHINOTERMITIDAE) CONTROL IN HAWAII. Yates, Julian R. III, J. Kenneth Grace, and Minoru Tamashiro (University of Hawaii, Department of Entomology, 3050 Maile Way, Honolulu, HI 96822).

Termiticide longevity and efficacy trials were established at six locations throughout Hawaii that differed in mean annual rainfall (48-391 cm) and elevation (6-230 m). Monolithic concrete slabs (76 X 76 X 10 cm) typical of slab-on-grade homes were formed over clay, sand, and gravel treated with either chlordane, chlorpyrifos, cyhalothrin, cypermethrin, fenvalerate, isofenphos, or permethrin termiticides at a rate of 2 gal/linear ft. The treatments were allowed to weather under the slabs at various concentrations ranging from 0.1-1.0%.

The treated substrates at all plot locations were sampled at annual intervals, and bioassayed in the laboratory to determine their effect on penetration, mortality, and repellency to *C. formosanus* workers and soldiers. We report our results through 1991 with termiticides weathered from 3 to 12 years.

STUDIES ON THE ESTERASE ISOZYMES OF COPTOTERMES FORMOSANUS SHIRAKI. Jia-qi Xing (Chinese Academy of Forestry, Beijing 100091, China)

The esterase isozymes of Coptotermes formosanus Shiraki and the inhibitory effects of six preservatives on the esterases of its workers were studied by means of polyacrylamide gel electrophoresis. It has been shown that there are some differences in esterase patterns between its king, queen, nymph, worker and soldier. According to the tests of inhibition, phoxim was the most active among the six chemicals, Decamethrin was the second, CCA and CCB, the two widely-used preservatives, were not active at all.

EFFECTS OF SODIUM BORATE AND CHLORTETRACYCLINE ON NASUTITERMES EXITIOSUS, AND COPTOTERMES ACINACIFORMIS. Joe K. Mauldin (USDA, Forest Service, Gulfport, Mississippi, USA), Michael Lenz (CSIRO, Division of Entomology, Canberra, Australia), J. A. L. Watson (CSIRO, Division of Entomology, Canberra, Australia)

Groups of termites were exposed in a choice foraging to small wood blocks of wood containing either sodium borate (disodium octaborate tetrahydrate) or chlortetracycline for 12 weeks under laboratory conditions. Statistical analyses of the data are not complete. Preliminary observations are as follows. Neither chemical seemed to have much effect on survival, feeding, or protozoan numbers in C. acinaciformis. When the termites fed on treated blocks, survival of N. exitiosus was affected, but many groups did not feed very much on the treated blocks. N. exitiosus termites readily fed on wood blocks treated with chlortetracycline and most of the termites died during the 12 week study.

FORAGING POPULATIONS OF SUBTERRANEAN TERMITES AFTER BAIT-TOXICANT APPLICATIONS. Nan-Yao Su (Ft. Lauderdale Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, Ft. Lauderdale, Florida, USA 33314)

Baiting programs utilizing a slow-acting toxicant, A-9248, reduced foraging populations of three colonies of the Formosan subterranean termite, C. formosanus, 65-98%. Although the results demonstrated that a toxicant bait can be used to suppress foraging populations of subterranean termite colonies and reduce their damaging potential, subsequent monitoring of these three colonies indicated that a total elimination of foraging activity was observed only from one colony.

EFFECTS OF SEVEN ANTIBIOTICS ON MORTALITY AND PROTOZOAN NUMBERS OF THE *Coptotermes formosānus* Shiraki (ISOPTERA, RHINOTERMITIDAE). Jun-hong Zhong & Li-lin Liu (Guangdong Entomological Institute, Guangzhou 510260, China).

The mortality and protozoan numbers of *Coptotermes formosanus* Shiraki were evaluated in groups of workers that had been kept for 1 to 4 weeks on filter paper treated with antibiotics.

Jinggangmycin, Qingfengmycin at 250 ppm and B-7 at 500 ppm caused 100% mortality of termites within 2 weeks. The mortality rates of the termites kept on M331, 1006-60, Cefalexin and Chlortetracyclin at 1000 ppm did not exceed 20% after 4 weeks, but were still significantly higher than in the controls (<10%). The number of hindgut protozoa decreased significantly after exposure to all antibiotics at the respective concentrations given above. The large flagellates *Pseudotrichonympha grassii* Koidzumi and *Holomastigotoides hartmanni* Koidzumi were more susceptible to the antibiotics than the small *Spirotrichonympha leidyi* Koidzumi.

Field trials with Jinggangmycin and Quingfengmycin against colonies of *C. formosanus* near Guangzhou are currently in progress. Laboratory and field experiments using the antibiotics against Australian species of termite have also commenced.

TOXICITY OF AMICAL 48 (DIIODOMETHYL P-TOLYL SULFONE) AGAINST THE RETICULITERMES ACULABIALIS (ISOPTERA: RHINOTERMITIDAE). Daorong Gao (Nanjing Institute of Termite Control, Nanjing 210002, China), Jackson Chan (Thomas Cowan & Co., Wanchai, Hong Kong), Stephen Ip (Pesticide Service Co. Ltd., North Point, Hong Kong)

The topical LD50 of AMICAL 48 (diiodomethyl p-tolyl sulfone) against the subterranean termite, Reticulitermes aculabialis Tsia et Hwang, was estimated at 115.0 ug/g with 95% fiducial limits of 102.6-129.0 ug/g. AMICAL 48 showed protracted activity against this termite. Time required to kill 90% of R. aculabialis (ELT90) was 5.3-15.2 d when administered topically, 4.2-12.7 d after 48-h forced feeding, and 3-11.3 d when R. aculabialis were confined continuously on treated feeding substrate.

PROSPECTS OF MICROBIAL INSECTICIDES FOR MANAGEMENT OF TEA PESTS IN SRI LANKA WITH SPECIAL REFERENCE TO LIVE-WOOD TERMITES. Sushila I. Vitarana, E.R. Perera, J. Bandaranayaka and L.S. Abeysinghe (Tea Research Institute of Sri Lanka, Talawakelle, Sri Lanka)

Kalotermitid termites which live exclusively within the tea plant feeding on live-wood, a habit unique to those endemic to Sri Lanka, require 100% eradication by any control agent. For, any residual population can build up, leading to premature death of the plant which otherwise grows for several decades.

Two entomopathogenic nematodes, one in a commercial formulation (BioSafe) and 5 strains of *Metarrhizium anisopliae*, one in the form of BIO 1020, have been tested on geographically isolated species of termites (*Postelectrotermes militaris, Glyptotermes dilatatus* and *Neotermes greeni*)

A new technique of treatment at "culling and burial" and another of "entrapping the agent with the pest" have been described. Treatment techniques match the different habits of the species.

"Irrigation" is shown to be essential to maintain the humidity necessary for efficacy of microbial agents. BIO 1020 has given promising residual action.

Feasibility of using microbial insecticides in IPM systems of Tea Termites is discussed.

THE TRAP-TREAT-RELEASE TECHNIQUE FOR CONTROL OF SUBTERRANEAN TERMITES. T. G. Myles. (Faculty of Forestry, University of Toronto, 33 Willcocks Street, Toronto, Ontario, M5S 3B3, CANADA)

Termites are social insects however the conventional chemical soil barrier method of subterranean termite control is not adapted to exploit their social behaviour. Termite social behaviour results in aggregations of populations and in exchanges between individuals. These features can be exploited to control termites.

Termite control strategies can be divided into two categories: *barrier strategies* and *delayed-mortality* strategies. Barrier strategies can be divided into chemical and physical (proper construction, termite shields, and sand barriers). Among the delayed-mortality strategies we can separate two categories: *baiting strategies* and *trapping strategies*. Baiting strategies rely on voluntary ingestion of toxicants and trophallactic transmission by intoxicated individuals therefore the amount of toxicant transmitted is small. Trapping strategies are more flexible in the types of treatment that can be administered to the trapped individuals and have the advantage of offering direct cuticular application. The treated individuals can carry relatively large amounts of toxicants, IGRs, or pathogens, which are transmitted as nestmates engage in grooming behaviour. Thus higher effective lethal ratios of transmission should be achievable by this general strategy.

RESEARCH ON CONTROL OF ODONTOTERMES FORMOSANUS (SHIRAKI) AND MACROTERMES BARNEYI LIGHT IN CHINA. Dong Li, Qi-zhen Rao, Li-ling Chen, Wei-jin Tian (Guangdong Entomological institute, Guangzhou, 510260, China)

Termites Odontotermes formosanus (Shiraki) and Macrotermes barneyi Light are principal insects damaging dikes and reservoirs in South China. Their damage usually generate "a small leak will sink a great ship".

Having studied biological characters, rules of activities and the methods of controlling them for many years, we have obtained satisfactory results technologically and theoretically. For example, the location of the main nests with reference to the distribution of the normal and abnormal holes of the incipient colonies was investigated. The findings can provide us a theoretical basis to locate the main nests. The termites can be effectively killed by using poisonous baits and the growth of the fungus Xylaria nigripes can be a very useful information concerning the location of the nests which can be consolidated.

BIORATIONAL INSECTICIDES: ARE THEY PROMISING FOR TERMITE CONTROL? J. Křeček, I. Hrdý (Institute of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, Praha, Czechoslovakia)

When exposed to Juvenile Hormone Mimics (JHM), termite larvae and pseudergates will differentiate into soldier caste. The presence of superfluous presoldiers and intercastes may cause disorder in the homeostasis of the colony. The first juvenoids of 2,4-dodecadienoate type (hydroprene, methoprene), active in laboratory tests, failed when applied in the field. Some stable and highly active aromatic JHM were identified in targeted screening with termites (Kalotermitidae, Hodotermitidae, Rhinotermitidae). A new carbamate derivative of 2-(4-hydroxybenzyl)-1-cyclohexanone seems to be promising for further experimentation because of its safety for water organisms (LC 50 Poecilia reticulata > 10 000 ppm, Daphnia magna = 6 050 ppm).

SOME REPELLENT SUBSTANCE TO TREMITE, *COPTOTERMES FORMOSANUS* SHIRAKI. Shiryo Yaga, Kazuhiko Kinjo and Hiroya Hayashi (Department of Bioscience and Biotechnology, College of Agriculture, University of the Ryukyus, Nishihara-cho, Okinawa 903-01 Japan)

Generally speaking, a phytophagous insect selects a host plant.

The most of plants do not become host plant for insects, because of the reason the plant has no attractant and/or arrestant, or has a feeling deterrent and/or repellent. The repellent contains extracts from the plant, which show negative phototaxis. An insect, as well known, is classified into monophagous, oligophagous and polyphagous by the limits of feed respectively.

A termite shows polyphagous and takes a dry timber. Seventeen species of termite live in Japan. Among them, subterranen termite, *Coptotermes formosanus*, *Reticulitermes speratus* Kolbe, and dry termite, *Cryptotermes domesticus* Hariland are the most injurious for human being and could give severe economic damages.

At present, the termiticidal chemicals are used mainly to kill insect. It is undesirable for environment of earth.

In this paper, some natural substances from plant which possess functional repellent were investigated against subterranen termite, *Coptotermes formosanus* Shiraki.

Non-Traditional Alternatives for Termite Control: a California Experience

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In California, like other parts of the world, there is increased interest in developing non-traditional alternatives for termite control. A number of these techniques are non-chemical and are now commerically available. Non-chemical termite control techniques include: microwaves, heat, cold, electrical shock, electrial barriers, physical barriers, and biological control.

Although laboratory efficacy data exists for some of these non-chemical control techniques, field data is still incomplete. In today's presentation I will review laboratory and field studies, as well as my experiences with a number of non-chemical termite control methods currently offered in California.

TERMITE ANTIFEEDANT ACTIVITIES IN TROPICAL PLANTS AND A NEW INVESTIGATION METHOD.

P. ESCOUBAS, L. LAJIDE, J. MIZUTANI. (Research Development Corporation of Japan (JRDC). Eniwa RBP, Eniwa-shi, Megumino Kita 3-1-1, Hokkaido 061-13, Japan).

We have examined a series of selected West African plant samples for their termite feeding-deterrent properties. We used a filter-paper choice bioassay technique in which consumed surfaces were measured using video-image analysis. In the course of this project, we have also developed a novel investigation technique, based on the principle of bioautography. Observation of termite feeding on developed TLC plates, coated with a mixture of agar and cellulose powder, has enabled us to quickly localize and isolate the active constituents from the crude extract by calculating *Rf* values of uneaten areas. This technique has been successfully applied in the study of several *Xanthoxylum xanthoxyloides* (Rutaceae) fractions. Details of the technique, and strutures of active constituents will be discussed, as well as global results of the sreening and potential applications of this work.

THE STUDY ON THE TOXICITY OF METHANOL EXTRACT FROM ENTEROLOBIUM CYCLOCARPUM(JACQ.)(STEM BARK) TO TERMITE, COPTOTERMES FORMOSANUS SHIRAKI. Yi Wang, Hong Huang, Mingling Wu, Yunhui Huang, Zhenyou Huang (Guangdong Entomological Institute, Guangzhou, 510260, China)

The methanol extract of stem bark of Enterolobium cyclocarpum (Jacq.)had the best termiticidal activity to the worders of Coptotermes formosanus Shiraki among three extracts: petroleum ehter, ethyl acetate and methanol. Treated with 2ml methanol extract(equivalently, 2ml of the extract was derived from 1g dried stem bark) per filter paper, the mortality of termite was over 98% within 7 days. LC50 (96 hours) of the extract was 0.98ml/paper. It was found that the mortalities of 4ml/paper and 2ml/paper were 84.25% and 55.75% in 4 days when only 6.75% and 3.75% in 2 days, respectively. Separation of the methanol ectract was performed through silica gel column flesh chromatography. Two crystals, brown and colourless, were isolated in fraction 18 and 19, Further bioassay demonstrated that these two fractions were as effective as the crude extract and the symptom of the dead termites was similar.

YEARROUND REARING OF BUMBLEBEES (BOMBUS TERRESTRIS L.) FOR CROP POLLINATION. A. de Ruijter, (Research Centre for Insect Pollination and Beekeeping, Ambrosiusweg 1, 5081 NV Hilvarenbeek, Netherlands)

After we had proved that insect pollination can replace hand pollination in greenhouse tomatoes, a method was developped to rear bumblebee colonies yearround. Bumblebee colonies are reared inside a climate room at 29°C and a R.H. of 50%-60% in the dark. After mating, young queens get a CO_2 narcosis twice for half an hour to prevent them from going into diapause. We use newly emerged honeybees (Apis mellifera L.) to stimulate brood activity. Several private firms have now started the production of bumblebee colonies for tomato pollination. In Western Europe about 300000 bumblebee colonies are now produced each year to pollinate about 6000 hectares of greenhouse tomatoes.

With bumblebee colonies available yearround, we started to compare the use of bumblebees and the use of honeybees for the pollination of other crops as well. Results of pollination experiments are given on strawberry, blueberry and red currents.

RESEARCHES ON THE BENEFIT OF THE PRODUCTION OF THE AUTONOMIC PATHENCARPY CUCUMBER BREED POLLINATED BY HONEYBEES. Shikui Liang, Jiacong Wang, Jie Wu (Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, Beijing 100093, China), Naiguang Li (Jushan Farm, Beijing 100093, China)

The present study was carried out on using honeybees as pollinators for the autonomic pathencarpy cucumber breed. The results indicated that the weight of cucumber in honeybee-pollinated plots can be raised by 27. 27-39. 70% over the plots without honeybees. The weight of high quality cucumber and the fruiting rate in honeybee-pollinated plots can be raised by 18.43-37.90% and 35.80-77.22%, respectively, over the plots without bees. Quality tests indicated that the average percent of dry matter of cucumber in pollinated plots and in that without bees were 3.37% and 3.71%, respectively, the amounts of carbohydrates were 1.99% and 2. 21% , and vitamin C, 0.00525% and 0. 005% , respectively. According to the price of cucumber at that time, we could get 1,000 Yuan (RMB) per 1/15 hectar over those without bees.

USING EUROPEAN HONEY BEE FOR POLLINATION OF LYCHEE CV. KOM. Saner Buranapawang, Somnuk Boongird (Apiculture and Industrial Entomology Research Group, Entomology and Zoology Division. Department of Agriculture (Ministry of Agriculture and Cooperatives), Bang-Khen, Bangkok, Thailand 10903)

Lychee (*Litchi chenensis* L. :Sapindaceae) cv. Kom was gynoecious. It is necessary for them to receive pollen from other varieties so-called pollinizer and the insect pollinators were secondary requirement of pollination process of lychee cv. Kom. *Apis florea* was predominantly found on lychee flowers as pollinator its number was inadequate, therefore, the introduction of European honey bee colony has been placed during lychee cv. kom blossom, It was found that *Apis mellifera* visited the lychee flower collect pollen from lychee cv. Thai and cv. Jeen in the morning and nectar from lychee cv. kom, cv. Jeen and Thai in later. The fruit set of lychee cv. kom was satisfied at the rate 2 acre/colony.

UTILIZATION OF *OSMIA* BEES AS POLLINATORS FOR FRUIT TREES IN CHINA. **Wei-Ru Zhou, Ren Wang (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China), Shu-Ge Wei (Institute of Pomology, Hebei Academy of Agricultural and Forestry Sciences, Shijiazhuang, China)**

Five species of wild *Osmia* [Hym.: Megachilidae] bees were identified from the apple orchards of Jiaodong Peninsula, Shandong Province, China during 1987-1991. They were: *Osmia excavata* Alfk, *O. jacoti* Ckll. *O. cornifrons* (Rad.), *O. pedicornis* Ckll. and *O. taurus* Smith. Comparative studies were conducted on the influence of temperature on adult activity, range and speed of foraging, and mating and nesting behavior of *O. excavata*, *O. jacoti* and *O. cornifrons*. The fruit set rates of the apple cultivar "Ralls" were 92.9%, 77.6% and 42.5% after a single visit by *O. excavata*, *O. jacoti* and *Apis mellifera*, respectively. Releasing 1,000-1,500 *Osmia* bees/ha significantly increased fruit yield and improved fruit quality. The fruit set rates of apple, pear, peach and apricot were 150-250% of those pollinated naturally. In 1991, *O. excavata*, *O. jacoti* and *O. cornifrons* were supplied commercially and utilized in over 50 orchards in 5 provinces.

POLLINATION OF ERICACEAE IN SOUTH AFRICA. J.H. Giliomee and D.B. MacGillivrae, Department of Entomology and Nematology, University of Stellenbosch, 7600 South Africa.

The insect pollination of nine ericaceous species viz. Erica grandiflora L.f., E.plukenetii L., E.sphaeroidea Dulfer., E.curvirostris Salisb., E.articularis L., E.caffra L., E.intervallaris Dulfer., E.nudiflora L. and Blaeria dumosa Wendl. was investigated. Pollen loads of captured insects were removed by means of a centrifuging method developed during this study and the individual loads analyzed both quantitively (applying systematic sampling) and qualitively (using SEM photographs and reference slides). Thirty seven insect visitors, all hymenopteran, were collected over the whole spectrum of Ericaceae studied: 34 were considered potential pollinators. These potential pollinators represented the families Anthophoridae, Apidae, Colletidae and Halictidae. The honeybee, Apis mellifera, was the most common visitor to the Ericaceae studied, occurring on eight of the nine species. Bees were observed entering the flowers of the putatively bird-pollinated E.grandiflora and E.plukenetti. Exclusion experiments conducted on virgin inflorescences of these species showed that insects were their main pollinators. Most potential pollinator species were generalist foragers, containing both host and non-host pollen in their loads.

EFFECT OF HONEY BEES IN INCREASING THE YIELD OF SUNFLOWER. **A. Mirabzadeh** (Iranian Research Organization for Science and Technology Teh. Iran) **H. Shadino** (Oil Seed Research and Development Co. Teh. Iran) **M. Mashayekhi** (Resesrch Organization of Agriculture, Teh. Iran)

The sunflower a protanderic allogamous plant, needs the interference of insect pollinators in transferring pollens from male stage to female stage. Sunflower produces a lot of pollen and nectar which is attractive to honey bees and other bee pollinators. Sunflower seeds contain up to 50 percent oil and since great amount of oil is imported to Iran, any efforts to increase the production is worthwhile.

Investigations in summer of 1990 in Sari (MAZANDARAN) showed that establishment of 2 hives per hectar resulted in 1100kg yield compared with the 900kg in the control. This figure compared with the average local yield of 300kg per hectar shows considerable increase. In treated and control fields ten samples of one sq. met. were taken and weighed, but there wasn't any significant difference between them as calculated by t, test.

To have similar conditions in both fields the distance between them was about three Kms. No doubt the bees of treated field have foraged the control so the yield of the control field was close to the treated one.

SEASONAL AND GEOGRAPHICAL DISTRIBUTION OF SIX HORNET SPECIES ALONG THE CENTRAL CROSS-ISLAND HIGHWAY, TAIWAN. Jung tai Chao (Division of Forest Protection, Taiwan Forestry Researeh Institute, 53 Nanhai Road, Taipei, Taiwan, China)

Forty-six traps were set at intervals of one or two kilometers along the Central Cross-Island Highway from an elevation of 50m to an elevation of 2,565m in the year from July 1990 to July 1991. A total of 45 weekly collections were made of 2,402 hornets belonging to six species. Forty nine percent(1,178/2,402) of the trapped hornets were Vespa velutina. Although V. velutina were found in traps throughout the year, 73.2%(863/1,178) were captured between September and January. While most V. wilemani, or 78.6%(522/664), were trapped between August and October, none were trapped in the two months of January and February. V. basalis was trapped every month of the study period except July 1991. The majority of V. basalis, or 68%(156/200), were captured from September to November. Most V. manderinia —82.5%(141/171)— were trapped from September to December, while none were trapped between the months of January and April. V. analis were captured in the greatest numbers —82.6%(71/86)— from September through December, while none were recorded from February to April. Of V. ducalis, 81.9%(68/83) were trapped from August to October, and none were captured from December to April. In terms of vertical distribution, 74.7%(62/83) of V. ducalis and 62.9%(107/171) of V. manderinia were trapped below the elevation of 1,000m; 77.9%(67/86) of V. analis and 56.3%(124/220) of V. basilis were trapped between the elevations of 1,000m and 2,000m; 92.4%(615/664) of V. wilemani were trapped above an elevation of 2,000m. V. velutina was widely distributed: 27%(319/1,178) captured below 1,000m; 44.6%(526/1,178) trapped between 1,000m and 2,000m; and 28.9%(333/1,178) captured above 2,000m. The implications of the seasonal and geographical distribution of these hornet species are discussed.

HOMOLOGY OF ANTS, BEES, TERMITES AND WASPS WITH THE SOCIAL MAMMALS INCLUDING MAN. R. V. Singh, Vijay V. Singh and Ujjal S. Bhatti (Department of Zoology, I. P. Degree College (Meerut Uni) Bulandshar (U.P) 203001,India)

In the past, numerous reports have appeared as to how the social insects (bees, wasps, ants and termites) look like, feed, reproduce and exert their influence on the flora and fauna of the world by their live habits. The role of bees and other insects in pollinating the flowers is paramounting. Isopterans, hymenopterans and the multitudes of other insects together with abundant blossoms and fruits, seeds provide the food for a great variety of birds, lizards and mammals (Bhatti, *et al.* 1992). The role of social insects is not less in any way than *Homo sapiens* -the supreme. In the present study an attempt has been made to, more or less, establish a homology between the social insect species and the social mammals inclusive of modern man. In-depth investigations were made for the last 15 years to observe and record information on various aspects of life activities between these two organismic entities. Before writing their homologies, organization, motility, group size, nesting/housing, hoarding, parental care, cost of evolution, etc. used.

A STUDY ON ORANGE YIELD EFFECTS POLLINATED BY HONEY BEE AND ITS MECHANISM. Shenlu Chen, Bujin Xu, Quansheng Gao, Xuezhen Lin (Zhejiang Agricultural University, Hangzhou 310029, China), Baishou Zhang (Quzhou Orange Research Institute, Zhejiang 324000, China)

A research in honey bee pollination for orange trees (Citrus reticulata cv. Ponkan) was conducted at Quzhou Orange Research Institute in netted house. The orange trees pollinated with honey bee were as treatment, and those pollinated without honey bee as control. The results showed an increase of 54.24%, of fruiting ratio and 39.07% of orange yield compared with those of the control. The pollination physiology was investigated by using photomicroscope technique, anatomy, radioisotope tracing technique, etc. It was found that the number of pollens on the stigmas of the flowers visited by bee was 16 times more than that of the stigmas not bee pollinated. Pollens carried onto the stigma by bee were germinated within 24 hrs. Within 72 hrs the pollen tubes grew to one fourth of the style, and the pollen tubes reached the ovary within 120 hrs afterbee pollination. The number of pollens on the stigmas of those flowers unvisited by bee was not only less but also germinated later. On an average, the seeds from treatment had 6.66 adventitious embryos, while the seeds from control had only 4.53. By using radioisotope tracing technique, products of 14-C photosynthesis and 32-P transported to young orange fruits of the treatment were 39.1%, and 50% higher than those of the control respectively. It was obvious that a series of physiological changes led to the increase of fruiting ratio and the yield of the treatment.

THE IDENTIFICATION OF A NEW VIRUS-HONEYBEE PUPA DISEASE-VIRUS. Feng Feng,[1] Shujing Chen,[1] Xicai Yang,[2] Xuedong Cang[1](1. Institute of Apiculture Research, Chinese Academy of Agricultural Sciences, Beijing 100093, China; 2. Institute of Micrology, Academia Sinica, Beijing, China)

The Virus was purified from dead worker pupae by differential centrifugation and sucrose density gradient centrifugation. It is spherical and about 20nm in diam. We discoveried same virus from diseased bee queen and a head and middle digestive of bee pupae by electromicroscopy, immuelectromicroscopy and ultrathin sectioning.

It contained dsRNA Nucleic acid are six components by SDS acrytamide gels. Molecular is 0.944×10^6, 0.863×10^6, 0.825×10^6, 0.754×10^6 0.713×10^6, 0.675×10^6. Sedimentation coefficient is 50.8S. Analysis of the virus protein on 10% polyacrymide gels showed only one component of estimated molecular weight 25.8×10^3 immonodiffusion tests in an agar with antisera against show that the virus unrelated to other from diseased bees (Apis mellifera)

Results of identification show that bee pupa virus is a new bee virus.

STUDIES ON ISOLATION AND PATHOGENICITY OF HONEYBEE SPIROPLASMA. Bing-yi Dong, Yun-qiao Qi, Shao-yu Xu (Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, Beijing, China) Yong-xuan Chen, Yong-hong Guo (Nanjing Agricultural University)

Spiroplasma has been isolated and cultured from both hemolymph and digestive track of honeybees in some provinces of China. These isolates of spiroplasma have typical fred-egg colonies on solid medium. The isolated spiroplasma is a kind of wall-free organism and has small, motile and helical shape. ELISA and deformation tests showed these isolates are related to spiroplasma melliferum (isolate CH-1).

Pathogenicity tests of spiroplasma isolates, 90-01 and 90-02, were determined by feeding and microinjection experiments. 75% of the tested bees fed with 8×10^4 spiroplasmas died within 25 days. Microinjection, with 1.4×10^4 spiroplasmas, through the intersegmental membrane using fine glass capillary tubes, caused all tested bees died off within 72 hours; whereas, 100% of bees injected with spiroplasma free buffer remained alive for 25 days. Results showed that spiroplasma isolates, 90-01 and 90-02, were found to be pathogenic and lethal to the honeybees.

BIOLOGY AND CONTROL OF THE PARASITIC BEE MITE *TROPILAELAPS CLAREAE*

J. Woyke, Bee Division, Agricultural University, Warsaw, Poland

Tropilaelaps clareae is considered to be more destructive to honeybee *Apis mellifera*, than *Varroa jacobsoni*. Below, results of investigations are presented, which were conducted in several Asian countries including China.

T. clareae infested adult workers always in lower percentage (1.5%) than *V. jacobsoni* did (5%). However, the first infested worker brood always in higher percentage (37%) than the second (14%). This means, that *T. clareae* must stay outside worker brood for shorter period, than *V. jacobsoni*. Woyke (1989) found in China, that the thickness of *T. clareae* females doubled from 0.30 mm in those moving freely on bee combs to 0.58 - 0.64 mm in females on bee brood 48-52 h after cell sealing. The first eggs were found in China 48 h after brood sealing. It is concluded that only swollen females lay eggs. The total development period of *T. clareae* in bee brood cell lasted 6 days (Woyke 1987). One female produced roughly two descendants. The sex ratio within the offspring was 1 male to 2 females. According to Woyke (1987) adult *T. clareae* mite stayed outside sealed bee brood for 2 days. *V. jacobsoni* stays on the avg for 13 days. Thus *T. clareae* can produce two generations within 25 days, while *V. jacobsoni* one only. Hence, the shorter period of *T. clareae* stay outside sealed brood cells must be considered as the main factor responsible for the more rapid increase of *T. clareae* than *V. jacobsoni* population. Woyke (1984) found that *T. clareae* can survive on adult worker bees in absence of bee brood for 2-3 days. This phenomenon allowed to elaborate a method to combat that mite without the use of any drugs (Woyke 1984, 1985). There suffices to deprive bee colonies of all the brood for few days. Another possibility is to cage the queen for 3 weeks to interrupt brood rearing until all workers emerge from comb cells.

STUDIES ON THE COMPARISON OF AChE PROPERTIES BETWEEN THE APIS CERANA FABRICOUS AND A. MELLIFERA LINNAEUS. Jian-mei Yang, Jian Jiang Miao (Department of Biology, Peking University, Beijing 100871, China)

The AChE properties of two species of honey bee were investigated. The results showed that the reaction characterization of AChE from A.cerana and A.mellifera and substrate (ATCh) were significantly different. In A.cerana, the initial velocity and the range of linear relative time of the reaction curve were 0.027 (O.D/min/0.8 head) and 0-10 min; but in A.mellifera were 0.012 and 0-15 respectively. In A. cerana, the Km and Vmax were 6.25 m mol/L and 0.105(O.D/min/0.4 head); however, in A.mellifera they were 0.862 and 0.015 (Km of A.mellifera is only 13.8% while Vmax of A.mellifera is 14.3% of A.cerana). There were no significant differences between two species on the Ki,K2,Kd and I_{50} of AChE with Propoxer, while the Ki, K2,Kd and I_{50} were obviously different with Trichlophen. The relative folds were 2.7, 1.39, 1.94 and 5.64 respectively.

It suggests that the reaction characterization of AChEs with carbamate or organophosphorus insecticides are different between A. cerana and A. mellifera.

HONEY BEE DISEASES AND PESTS IN JORDAN. Ibrahim K. Nazer and Jamal M. Ratel (Faculty of Agriculture, University of Jordan, Amman, Jordan).

The status of honey bee diseases and arthropodal pests was evaluated. The total of (20) apiaries were visited and (89) hives inspected. From every hive, adult workers and sections of capped brood (10×5cm) were taken to conduct various tests.

The following arthropodal pests were recorded: Varroa mite, oriental wasp, greater wax moth, and bee louse.

Recorded adult bee brood diseases included: American Foul Brood, European Foul Brood, Chalk Brood and Nosema.

Four commercially used acaricides were evaluated against Varroa mite. These were: Amitraz, Bromopropylate, Coumaphos and Fluvalinate.

All four compounds were highly effective and significantly different from the untreated ones.

No infestation with tracheal mites was recorded.

#1

SOME KINDS OF WILK-GROWING BEES LIVING IN YUNNAN PROVINCE, CHINA. Dean Zhuang (Guizhou Academy of Agricultural Sciences, Guizhou 550006, China) Ruyun Gan, Zuji Zeng, Zuncheng Lin (Bureau of Animal Husbandry of Yunnan, Yunnan 650021, China)

Some aspects of the life of Megapis dorsata Fab, Magapis himulayana Maa 1944, and andreniformis Smith in the thick forest of Xishuangbanna, Yunnan province were introduced. At the same time, one kind of Eucharitida was introduced as well. It was discovered that the honeycomb was composed of individual Cylindrical cells with blocked ends. Until their eclosion the larvae had been taking the bee-bread that was kept inside the cells before being blocked.

#2

APPLICATION OF HONEYBEES TO POLLINAT VEGETABLES IN THE GREENHOUSE. Shoumu Qu, Xiaorui Pan, Zengshui Yu (Honeybee manage station. Beijing 100029. China) Changguo Liu, Yuedong Xu, Guoliang Jing (Pinggu Forest Bureau. Beining 101200. China)

The vegetables in greenhouse are planted in winter and spring and wild insects are few at that time. which certainly influence the yield and quality of cross pollinating plants. This paper studied honeybees were employed to pollinat cucumber and pumpkin. The greenhouse were covered with plastic sheet, under which window screening was used to prevent bees flying out. 4 bee chests were placed in the cucumber and pumpkin houses respectively. The results showed: 1. In the pumpkin plots pollinated by bees. 65 fruits seated per 100 plants, which weighted 86.5kg, in control areas. 371 fruits. 47.8kg; in the cucumber plots. 759 fruits. 95.8kg. in control areas. 649 fruits. 74.5kg. The rate of fruits seated and the yield of these two vegetables were higher in the treatment plots than that in control ones. 2. The pattern of cucumber in the treatment areas were relatively well-proportioned. 3. Honeybees used in the treatment developed normally.

#3

THE BEE POLLINATION, AS A NEW TECHNIQUE TO INCREASE THE QUALITY AND QUANTITY OF WATERMELON. Feng-he Wang, Li-gang Jiang, Bao-long Wang, Yi-pu Zhang, Guang-he Song(Institute of Animal Husbandry Sciences, Beijing Academy of Agricultural and Forestry Sciences, Beijing 1000 ,China), Bao-gen Shen(Beijing Entension Station of Agricultural Technology, Beijing 1000 , China), Chang-mao Xu, Xue-bin Han(Diversification Corporation of Xiaodian Township, Shunyi County, Beijing 1 ,China)

The present paper concerns with the application of bee pollination in watermelon production to replace the artificial pollination so as to reduce the labour intensity and raise the quality and quantity of the final product. Results from our trials in 1990 and 1991 showed that in the preserved land where bee pollination was adopted, an increase of 16.2 to 22.4% in production was achieved, sugar content of the melon increased by 0.48 to 0.53% in comparison with the control groups where artificial pollination was applied. In the open field that adopted bee pollination, the melon production increased by 11.4 to 14.36%, and sugar content increased by 0.49 to 0.68% in comparison with the control groups that artificial pollination adopted. With adoption of bee pollination, the plant bore more fruits, matured earlier, and the melon quality was higher, sugar distribution was more even, and the edibility was better.

#4

BEEFLORA AND BEEKEEPING IN KOLAR DISTRICT, KARNATAKA, INDIA.
V. Sivaram (Department of Botany, Bangalore University, Bangalore 560 056, India), C.C. Reddy (Department of Zoology, Bangalore University, Bangalore-56, India.)

A detailed survey on honeybee flora and beekeeping practice was carried out at regular intervals during 1989-90. The identified beeflora were classified into pollen yielding, nectar yielding or both. The study reveals that the beekeeping has been practiced time immemorial in the district. Annual yield per colony (Apis cerana F.), colony density were significantly low when compared to other parts of the beekeeping areas in the State of Karnataka, India.

Information on identification, type of beeforage, plant family, habit and habitat, method of propagation of beeflora besides floral calendar was provided to ensure continuous flow of nectar and pollen to honeybees. The ways of increasing annual honey production through sustainable beekeeping management has been discussed in the light of the available results.

#5

FUZZY GENETICS AND THE PRODUCTION INCREASING EFFECT OF THE COMBINED COLONY OF HONEYBEES. Zhuang Dean (Guizhou Academy of Agricultural Sciences, Guizhou 550006, China), Yiji Wang, Taihe Liu (Shandong Agricultural University, Shandong 271018, China)

Regarding both genetic information and environmental information as being fuzzy, this is the very basic point of view of fuzzy genetics. Fuzzy genetics regards production colony as a fuzzy subset is a individual, that is to say, a individual carrying the genetic information. For a fairly period, couldn't we understand thoroughly the details of every fuzzy subset, but we can control the number and ratio of the different types of subsets conveyed to a colony. A combined colony is properly composed of different types of fuzzy subsets. The honey production of the combined bee colony is increased by 40% than that of the A. m. Ligustica usually kept here.

#6

A SIGNIFICANT VEIN VARIATION OF HONEYBEE, APIS MELLIFERA L.
Jian-qing Ding(Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081,China)

A large number of R_5-vein variation of forewings of honeybee (Apis mellifera L.) have been found when identifying the workers of the pure line bred by Mudanjiang Apiary of Heilongjiang Province in 1989. For this variation, R_5-vein was not linked with the cubital vein but disappeared in its terminal. So we could not measure and calculate the cubital index of this honeybee. The ratio for this variation of the three generations of the pure line was 80%, 23.2% and 2.4%, respectively. Expecially in the first generation, there were variations in 173 forewings of all 213 specimens identified. We have never found such a high ratio before. It is estimated that the variation is genetic in nature. In the future, this variation could be used as a special mark in honeybee breeding with special genetic method, so that we can prevent the imitative queens, because the new queen has no cubital index. Mudanjiang Apiary has been trying to regain and preserve this special pure line.

#7

Two species of blister beetles on the honey bee in Iran*

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Identification and the extent of damage of oil bee - tles Meloe spp (Meloidae col.) on honeybees was invest- igated. At least two species of these insects were col - lected from bee hives and apiaries in Zanjan, Deylaman (Rasht), Uromiae, Hamedan and Shahrekord (Isfahan).

Meloe variegatus (Donovon) with blackish triungulin is usually found on the body of honey bee and seldom leave it. This species is more frequent than Meloe proscara - baeus.

Meloe proscarabaeus (L.) with brownish triungulin is carried in to the hives by honeybees but usually leaves the adult bees there.

These insects have only one generation annually and overwinter as sixth instar larvae in the soil.

The larvae of these insects have been observed on pas - ture plants such as Renonculus sp. and Taraxacum sp.

Blister beetle larvae are not considered as serious pest for honey bees and require no special control at present.

#8

STUDIES ON THE RELATIONSHIP BETWEEN THE PRODUCTION OF ROYAL JELLY AND THE LARVA AGE OF HONEY BEE. Fu-hai Liu, Shi-bi Chen, Sheng-ming Han, Fu-xiu Liu (Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, Beijing 100093, China)

The results of investigations showed that the peak accumu- lated amount of royal jelly of honey bee Apis Mellifera Lin- naeus was attained at ninety six hs. after hatching. There was significantly positive correlation (r = 0.96) between the pro- duction of royal jelly collected at 48th h. after the larvae removed and the larva age ranged from 12 to 48 hs. old. As the larva age was more than sixty hs. old, the yield of royal jelly reduced lineally due to the more and more lower acceptability of royal jelly and the difficulty to remove the too big larvae. Consequently, the highest yield of royal jelly was obtained as the larvae removed at the age ranged from 12-24 hs. old.

#9

PRELIMINARY STUDY ON G-BANDING TECHNIQUE OF THE HAPLOID MALE APIS MELLIFERA CHROMOSOME. Xiao-ping Meng, Xian-shu Liu (Bee Research Institute of CAAS, Xiang Shan, Beijing 100093, China)

Techniques and results are presented for the G-banding on haploid males of Apis mellifera chromosome with carbamide method for the purpose of dedicating genetics and breeding of honey bee, as well as comparing with HOSHIBA's work.

The results and techniques of G-banding on haploid males of Apis mellifera chromosome are illustrated and discussed. G- banding karyotype patterns are discribed in a detailed way.

No. 1-16 were showed G-bands; some of them were stably distinguished.

Carbamide method, among the ones tried, was the best.

#10

A STUDY OF LABIAL GLANDS SECRETIVE LAW IN THE WORKER HONEYBEE (APIS CERANA FAB.). Li-jun Han, Zhi-lan Du (Department of Biology, Peking University, Beijing 100871, China), Ju-huai Li (Beijing Academy of Agriculture and Forestry Sciences, Beijing 100081, China)

The labial gland is responsible for producing the enzyme which inverts the sucrose of nectar or syrup. The result of which is the glucose and fructose in honey and it contacts with the metabolism of fat. With electro-focusing PAGE, the variations of protein and peptide and esterase isozyme with age and season were determined. It shows that protein and peptide content and esterase isozyme activity gradually increase and also their differences between winter and autumn exist. It is also verified by the electron microscopic observation. The gland acini of one-day-old bee are flat and gradually swell during maturation. In one-day- old bees, there are many rough endoplasmic reticulum with vecicular shapes and visible nuclei, but few mitochondrion and secretion masses and more heterochromatin in cell. With age increasing the mitochondrion and secretion masses increase. There are infoldings both on the apical side and on the basal side. In winter, the acini are almost flat. There are plenty of mitochondrin and rough endoplasmic recticulum and big nuclei in cell.

#11

A NEW METHOD FOR CONTROLLING TROPILAELAPS CLAREAE IN HONEY BEE COLONY. Zheng-ding Xu (Institute of Apicultural Research, Chinese Academy of Agricultural Sciences, Beijing 100093, China)

Based on the investigations of biological character of Tropi- laelaps clareae Delfinado et Baker for many years, it was found that this parasitic mite has a rigorous selectivity to the age of host - honey bee Apis spp., its survival and reproduction have to rely on the presence of available host larvae which are three days old or more. Otherwise, this mite must die out in the absence of the bee larvae in suitable age for more than two days. Consequently, a multi-functional partition plate made by gauze was designed to exclude the damage of this mite. The colony can be separated with this plate into two or more sections, by re- gulating the comb to keep each section without available host larvae for 2-3 days, the mortality of T. clareae fifteen days after will be more than 98%. By applying this method, there are no pollution problem to bee products and no damage to the deve- lopment of bee colony, the labour intensity of bee keeper can be reduced, and the benefit increased.

#12

BIONOMICS, DISTRIBUTION AND CONTROL OF BEE MITES (*VARROA UNDERWOODI*) IN KOREA. Kun-Suk Woo (Dept. of Appl. Entomol., Coll. of Agri. & Life Sci., Seoul Nat'l Univ., Suwon 441-744, Korea)

Studies were carried out to investigate some micro-morphological characters and development during hibernation of *Varroa underwoodi*, and the control efficacy of several smoking agents to it.

V. jacobsoni, a well-known bee mite, was recorded first in southern parts of Korea in 1950's. Distribution of it has been expanded all over the country and, at present, it has damaged seriously.

In 1991, we discovered another bee mite, *V. underwoodi*, from the oriental honeybee, *Apis cerana*. It is much smaller (body length x width: 749 um x 1263 um) than *V. jacobsoni*. It has been spreading out by migratory beekeeping in southern parts of Korea. *V. underwoodi* has not been found in the middle and the upper region of south Korea, and the same in *Apis mellifera*.

Folvex, Apistan, Amitraz etc. have been used as a smoking paper to control bee mites, and these agents induced some resistance on bee mite.

#13

Honeybee Parasitic Mites and their Management on Apis mellifera at the newly introduced place in South India

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An attempt has been made to introduce Apis mellifera for the first time to South India Bangalore - under Tropical conditions. Ten colonies of Apis mellifera were introduced from Hissar-Haryana, about 3000 km from Bangalore during November 1991. Among the several mites encountered, the parasitic brood mite Tropilaelaps clareae Delfinado & Baker Fam. Laelpidae order Mesostigmata was found causing problem to establish the colony. It layes eggs on young larvae in the cell and develops inside the cell. Although the ecto parasite Varroa jacobsoni is also reported to occur (1967) from Bangalore it is not found to cause problem. The methods of control adopted to prevent the parasitic mites in relation to the bahaviour of the European bee in its new environment are explained.

#14

ANTS OF VENEZUELA. CATALOGUE AND DISTRIBUTION. Pedro José Salinas (Universidad de Los Andes, Mérida, Venezuela)

A Catalogue of the ants of Venezuela is given, including species in the author's collection (about 4000 samples: mean of 10 individuals sample for a total of 40000 ants), as well as other cited in the literature. The "Catalogue of the Neotropical ants" (Kempf 1972) cites for Venezuela, 56 genera, 147 species, 26 subspecies, 14 varieties. There are 33 type species, 5 type subspecies, 10 type varieties described from Venezuela. In the author's collection there are more than 70 genera, 100 species, 20 subspecies, and at least 100 species to be determined. Bibliographic and ecological information on each species is given, such as references to original description, distribution in the Neotropical Region, and in Venezuela. For each State of the country, the localities and records number are included. Also ecological data such as altitudinal range, habitat, microhabitat, life zones, as well as other ethological data such as occurrence. Maps of Venezuela are given with the localities where the different species have been collected or recorded by other authors. List are given of all the ant species recorded in Venezuela and for each Federal entity. A list of the collection localities is given, including the geographic coordinates and the altitudes of each place.

#15

APPLYING ETHO-MODELLING TO SIMULATE THE SOCIAL ORGANIZATION OF AN ANT COLONY.

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This work introduces EMF (EthoModelling Framework) which defines a new method for modelling complex organizations such as insects societies. EMF, which is implemented in an object-oriented language (Smalltalk80), uses a behaviour-based approach focusing on the individual level and viewing organizations as emergent structures. In that way, it allows ethological methodologies to be involved in the modelling process. We describe here the kernel of EMF and its first application, the MANTA (Model of an ANTnest Activity) project, whose aim is to simulate the social behaviour of an *Ectatomma ruidum* (Ponerinae) ant colony. We show that this model is able to generate a social organization which is, particularly as concern the division of labour, closed to those observed in some natural *E.ruidum* societies.

#16

A COMPARITIVE STUDY OF ESTERASE ISOENZYMES IN SELECTED ANTS (HYMENOPTERA: FORMICIDAE). Ling-su Shen, Chang Hsu, Hui Wang, Jian Wu (Department of Plant Protection, Huazhong Agricultural University, Wuhan 430070, China)

Esterase isoenzymes of the samples of selected ants are studied with isoelectrofocusing(IEF). The samples were collected in the field of Wuhan, Hubei province. IEF was carried out in thin (0.5 mm) slab polyacrylamid gel. The comparitive studies include: (1) 4 samples which belong to different subfamilies, subfamily Formicinae,Ponerinae, Myrmicinae, and Dolichoderinae; (2) 5 samples of different genera of subfamily Myrmicinae, genus Pheidole, Pristomyrmex, Messor, Crematogaster, and Tetramorium; (3) 2 species of genus Paratrechina, Paratrechina sharpi (Forel) and Paratrechina bourbonica (Forel); (4) Workers of Brachyponera obscurans (Walker); (5) The worker and the sodier of Pheidole nodus Smith. The differences of esterase zymograms are quite large among subfamilies, genera, and species. No differences are found among workers of the same species. And only a few differences are found between the worker and the soldier. IEF may be used as a helpful tool in ant systematics.

#17

CONTROL OF HARMFUL ANTS IN SILKWORM ROOMS IN GUANGDONG, CHINA. Weijin Tian, Dong Li, Liling Chen, Qizhen Rao (Guangdong Entomological institute, Guangzhou, 510260, China), Xingguang Huang, Gaohong Zhong, Chaobin Yang, Kengzu Mao (Guangdong Silk Corporation, China)

This paper describes the main species of the ants harmful to Chinese silkworm, i.e. Monomorium pharaonis (L.); Pheidole nodus Smith; Pheidole indica Mery; Plaiolepis longipes Jerdon; Pheidologeton affinis (Jerdon); Pristomyrmex pungens Mery; Diacamma augosum (Le Guillou), and their form and damage, as well as the conditions of ecology and the pattern of activities in Guangdong, China. The three measures of physicial and chemical prevention and chemical killing against ant damage in sericulture were analysed.

The methods of direct lure, fixed position lure, and additional position lure, the poisonous baits of ants were studied.

#18

SUCCESSION DYNAMICS OF ANT COMMUNITIES IN SLOPES. Acosta, F.J.; Zorrilla, J.M.; López, F. & Serrano, J.M. (Departamento de Ecología, Facultad de Biología, Universidad Complutense de Madrid, 28040 Madrid, Spain).

The dynamics of ant communities in slope systems of pastures of Central Spain was studied at four different slopes on two time scales: a static scale, which was used to infer successional processes (using a sequence of 1 to 40 years), and a dynamic scale (three years of sampling). The heterogeneity in slope relief was compared with the variation in the species composition of the communities through time.

The communities tend to differ through succession according to their position in the slopes. This takes place with a progressive increase of the similarity between the relief and the communities description ("community topography") along the slopes. The inter-annual fluctuations in these ant communities show a decresase through succession, but this is appreciable only when the geomorphological structure is taken into account.

#19

COMPETITIVE INTERACTIONS IN THE HOME RANGE OF GRANIVORE ANT COLONIES. Acosta, F.J.; López, F.; Serrano, J.M. & Verdugo, M. (Departamento de Ecología, Facultad de Biología, Universidad Complutense de Madrid, 28040 Madrid, Spain).

In this work we investigate the intraspecific competitive relationships among colonies of the mediterranean granivore ant Messor barbarus (L.). In spite of studying the individual antagonistic responses, we have employed the location of nest entrance holes and different parts of the foraging trunk trails developed by this species, as a synthesis of the previous competitive interactions among different colonies. We analyze the co-occurrences or not of these different structures in the neighborhood of nest entrances.

#20

TECHNIQUE FOR CONTROLLING GREATER WAX MOTH, GALLERIA MELLONELLA IN THE BEE HIVES OF THE CHINESE HONEY BEE, APIS CERANA. Youfu Zhou (Guangdong Entomological Institute, Guangzhou, China)

The greater wax moth, Galleria mellonella is one of the most important enemies of the Chinese bee, Apis cerana. Based on the biology of the greater wax moth, the females do not directly lay their eggs in the combs of hives. Most of the eggs are laid in the slits of the bottom board of the hives and in the slits of the division boards. After the incubation of eggs, the first instar larvae crowled to the frames along the lugs connecting inside grooves of the hives, and then they bored into the combs. According to their habits, we have invented a kind of intercepter for preventing the first instar larvae from crawling into the combs. When using the intercepter, the standard hives needed to be modified slightly. Two intercepters were installed on each inside grooves of the front and hind walls of the hives,respectively. A piece of long board was fixed with screws and nuts on the top of the two intercepters for supporting the lugs of the frames and division boards. The two ends and outside of the board were 10mm away from the walls of the hives. The oinment pyrethrin and fanshilin were put into the intercepters before fixing them. The slits of the division boards were closely connected with the crack filler for preventing the greater wax moth from laying their eggs. The comparative experiments were conclucted under the same conditions, and the result showed that the average number of the larvae of the greater wax moth had decreased by 82-95.19%, bee population increased averagely by 10-31.03% and mean honey yield increased by 29-35.37% compared to the standard hives without the intercepters.

#21

PROSPECT OF APICULTURE IN THE YELLOW RIVER BASIN. Xian-dong Li (Research Fellow, Director of the Apiculture Institude of Yangquan, Sanxi 045000, China)

The author expounded that, in the Yellow River Basin, the conditions included the geographical environment, the climate, the superior resources of honey plants, the economical benefits and the prospect of beekeeping are advantageous for developing apiculture. The honey plant resources are about 6.67 million ha. In this area, which is able to maintain 3.3 million beehives, But there is only 1. 5 million beehives now. It is really worth developing such abound honey resources.

On account of the varied topography of the Basin, there are more than 30 kinds of main honey plants, such as rape, jujube tree, cry ptotaeneous cinguefoil, vitex, cotton, alfalifa, sweetclover, sunflower, scholartree etc. And many honey plants which are used as medicinal herbs, such as codonopsis palosula, Chinese wolfberry, astragalus membranaceus, etc.

The 3.3 million beehives can produce 150 thousand tons of honey, g handred tons of royal jelly and 15 thousand tons of pollen, which makes more than $ 100 million directly and $ 100 million indirectly. The Yellow Basin is the most potential base of honey plants resources and base of marke table honey in China.

#22

APITHERAPY. Fang Zhu (Liangyungang Apitherapy Hospital, Jiangsu Province, China)

Apitherapy is a therapeutic method by the utilization of bee, its secretory and collected materials as well as the apiary. Apitherapy belongs to the traditional nature cure. The adult bee, larva and pupa can all be used as medicine. The collected materials of bee include honey, bee pollen and propolis. These materals and the secretory material beeswax can also be used as tonic and therapeutic drug in traditional Chinese medicine. Bee venom, royal jelly and honeycomb have been used for a long time as medicine in the public and they are now produced in the factories. In some hospitals and sanatoria, the apiary has been established and bee acupuncture therapy has been adopted. The multiple natural factors in the apiary environment and the apiculture products have been proved beneficial to the elderly, the handicapped and the convalescent both physically and mentally.

#23

HONEY BEE DISEASES AND PESTS IN JORDAN. Ibrahim K. Nazer and Jamal M. Ratel (Faculty of Agriculture, University of Jordan, Amman. Jordan).

The status of honey bee diseases and arthropodal pests was evaluated. The total of (20) apiaries were visited and (89) hives inspected. From every hive, adult workers and sections of capped brood (10x5cm) were taken to conduct various tests.

The following arthropodal pests were recorded: Varroa mite, oriental wasp, greater wax moth, and bee louse.

Recorded adult bee brood diseases included: American Foul Brood, European Foul Brood, Chalk Brood and Nosema.

Four commercially used acaricides were evaluated against Varroa mite. These were: Amitraz, Bromopropylate, Coumaphos and Fluvalinate.

All four compounds were highly effective and significantly different from the untreated ones.

No infestation with tracheal mites was recorded.

#24

INVESTIGATIONS ON THE SPECIES DISTRIBUTIONS AND HARMFULNESS OF TERMITE IN HUBEI PROVINCE. Bo-yan Huang, Xue-yan Zhang, Wei-qiang Tao (Wuhan Institute of Termite control, Wuhan 430014, China)

Through choosing the sites for the investigation, about 17 species of termite have been collected and identified. Among them 4 species are new species, and 12 species are newly collected from Hubei province. The newly recording species are as follows: Reticulitermes sp., R. speratus , R. fukienesis, R. aculabialis, R. dabieshangersis, R. lii, R. cymbidii, R. longigula, R. higrobruneus, Capritermes sp., Pericapritermes yangtsekiangsis, Sinoapritermes magnus. The superior species of termite are Coptotermes formosanus,Reticulitermes chinensis and Odontotermes formosanus. The houses and buildings, living trees and dike have been endangered seriously by Coptotermes formosanus and Odontotermes formosanus in Hubei province. This paper also reported the distributions of termite in Hubei, and the methods of controlling termite were put forward and discussed.

#25

RESEACH ON TERMITE CONTROL OINTMENT Bao-hua Fang, Yu-nan Wang (Institute of Wuhan Termite Control, Wuhan 430060, China)

This paper reported the ingredients of termite control ointment, which is a powerful attractant and poison for termite. In termite control ointment, dodecachlorine-pentacyclo-decalkane is used as a poison, foxtail millet powder as a stuff, and fructose as a attractant. Results indicated that the application technique of termite control ointment is much simpler than that of termite control powder and powerful termite killer. Results also showed that termite control ointment is more poisonous and attractive than termite control powder and powerful termite killer, and its control effect for Coptotermes fomosanus Shimaki and Reticulitermes spp. inside and outside buildings is 98.5-100%. The termite control ointment is safe for men and animals. It does not injury the living plants and the constructions, also not pollute the environment. The price of the ointment is very cheap.

#26

THE RELATIONSHIP BETWEEN THE CLIMATIC FACTORS AND THE DEVELOPMENT OF DOMESTIC TERMITE FOR LONG WING REPRODUCTIVE TYPE. Yao-hua Li(Institute of Termite Control, Yichang 443000, China)

The relationship between the climatic factors and the development of domestic termite for long wing reproductive type was analysed with the method of statistics to the data of 27 years. The results are as follows: (1) The main climatic factors to affect the development of the termite for long wing reproductive type are air temperature and precipitation in the area of the same latitude and ecologic conditions. (2) The developmental luxuriant period-nymph period is the most susceptible period to be affected by the climatic factors, especially the air temperature and precipitation of February. (3) Among 7 climatic factors, only the precipitation of February is positive interrelated positively with the development of the termite. The other factors are negative interrelatived with the development of it. The greater is the absolute value of the climatic factors, the shorter is the developmental period of the termite for long wing reproductive type, and the earlier is the height of flying period.

#27

GRASS CONSUMPTION AND PREFERENCE IN THE HARVESTER TERMITE *TRINERVITERMES TRINERVOIDES* (SJöSTEDT) (ISOPTERA: TERMITIDAE). R.A. Adam, T.C. de K. van der Linde & M.C. van der Westhuizen. (Dept. Zoology and Entomology, University of the OFS, P.O. Box 339, Bloemfontein 9300, Republic of SA).

Trinervitermes trinervoides is a common mound building termite in South Africa. It has been suggested that this termite can remove between 20% and 60% of the standing grass (Coaton, 1951). Grass consumption and food preference was determined respectively in the veld and laboratory.

There is a significant ($t=18,175$; $P<0,05$) correlation between consumption and mound height. *T. trinervoides* removes grass at the rate of 234,1 kg/ha/year. Preference experiments revealed that *T. trinervoides* prefers standing grass to grass lying on the ground. They also preferred grass litter to any species of fresh dead grass offered.

Litter production is estimated at 1600 kg/ha/year. Consequently it is doubtful whether *T. trinervoides* is of significant economic importance in South Africa.

#28

THE EFFECT OF TEMPERATURE AND HUMIDITY ON THE FORAGING OF THE HARVESTER TERMITE *HODOTERMES MOSSAMBICUS* (HAGEN). Jannette Mitchell and T.C. de K. van der Linde (Dept. of Zoology and Entomology, University of the Orange Free State, Bloemfontein 9300, Rep. of SA).

Hodotermes mossambicus (Hagen) regularly occurs in regions experiencing high summer and low winter temperatures. Pigmented major and minor workers forage openly on the soil surface. The temperature tolerance limits of laboratory reared colonies of the species vary between 43.5°C and 48.5.3°C (CT Max) and between 5.3°C and 10.3°C (CT Min) over a range of acclimation temperatures (15°C - 35°C). Major and minor workers have both high CT Max and lower CT Min than unpigmented large larvae. The upper and lower temperature limits to foraging were 35.9°C - 40.5°C and 10.7°C - 11.2°C respectively, and are regarded as voluntary thermal limits for the species. The temperatures at which foraging intensity was greatest (optimal foraging temperature) lay between 25°C - 35°C while foraging efficiency was highest between 25°C - 30°C. Foraging intensity increased markedly at high humidities.

#29

OBSERVATIONS ON SWARMING & COLONY FOUNDATION OF DESERT HARVETER TERMITE, ANACATHOTERMES VAGANS(HAGEN)(ISOP.-HODOTERMITIDAE) IN KHORASSAN PROVINCE

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Anacanthotermes vagans is the most plentiful and widely distributed termite occuring in different parts of Khorassan province including pastures, rural and urban areas. Preliminary studies on bioecology of this termite have been conducted during 1986-1991. Investigations show that colonies are situated on uncultivated margins of fields, border plots, on the walls of ruined huts. Swarming takes place on the shiny day after the first spring rainfals from the morning till ½ hour before sunset. Alates of each colony swarm within 2-3 times during early March to middle May. Duration of swarming depends on the condition of the weather each time. The number of exit holes vary from 25-60 with an average of 40/colony. Exit holes have been seen on mounds, on boder plots and on the walls. Colonies are either small mounds with a height up to 30 Cms. or flat covered with clay particles in desert areas. The basal diameter of the mound is upto 120x90 Cm. Each exit hole is 10x7mm. wide. Dealated couple establish their nests beside the animal's dung and dead plant materials. More than one pair build their nests beside the same material. Indoor colonies founded by dealated couples survived > 3 months. Factors affecting mortality (biotic & abiotic) of swarmed alates have been known. Up to 16 dealated pairs have been found establishing their nests in an area of ½ square meter.

#30

PROTECTION OF NEW BUILDINGS AND OTHER STRUCTURES FROM SUBTERRANEAN TERMITES WITH A PHYSICAL BARRIER — A FINE MESH OF HIGH GRADE STAINLESS STEEL. Michael Lenz & Silvano Runko (CSIRO, Divsion of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia).

A new type of physical barrier for the prevention of attack by subterranean termites on buildings and other structures and materials in ground contact, a fine mesh of stainless steel, has recently been developed and patented worldwide by industry in Australia. CSIRO carried out laboratory and field trials to assess the termite resistance of the material. In the laboratory 25g groups of *Coptotermes acinaciformis* from 3 colonies, kept on a limited supply of food, were unable over a 12 week period to breach a barrier of the steel mesh that separated them from a supply of highly susceptible wood. Timber enclosed with mesh was buried below ground at two sites in Australia, one in the tropics and the other in the southern inland. A variety of species of termite, including *Mastotermes darwiniesis*, *C. acinaciformis*, several species of *Schedorhinotermes* and *Heterotermes* and others were unable to reach and damage the wood despite making intensive contact with the mesh surface for a year. The excellent resistance of the high-alloy steel to corrosion ensures that the mesh barrier will remain effective in excluding termites for many years. The material under investigation has a mesh width of 0.60 x 0.60 mm and its wire strands have a diameter of 0.28 mm. The size of the mesh openings can be varied to exclude the smallest representatives of the termite fauna at a given site. Some aspects of incorporating a barrier system of stainless steel mesh into the design of buildings, and other examples of its use, are given.

#31
SPECIES OF ISOPTERA IN ANHUI PROVINCE AND MAIN FACTORS AFFECTING THEIR DISTRIBUTION. Li-qun Yao (Hefei Institute of Termite Control, Anhui 230001, China)

There are 33 species of termites recorded in Anhui Province so far. From north to south, the number of species increased, the distributive area extends, and shows regional charateristic. This distributive trend shows the characters of the geographical location, humiture, physical and chemical properties of soil and vegetative resource of this province.

The termite fauna in Anhui shows that these are both oriental and palaearctic species. To the south of Huaihe River, oriental species are dominant, with some palaearctic species mixed. There is a clear northern boundary for each genus or species, it is related to humiture. soil and vegetation factors, but their distributive areas often overlap in southern Anhui and shows a complexity. According to their distributions. the main factors affecting the distribution of Coptotermes is humiture, for Reticulitermes are the amount of mean annual precipitation and pH of soil, for Odontotermes and Macrotermes pH. structure and depth of soil, and for Nasutitermes their hosts-vegetations.

#32
REVIEW ON TERMITES DAMAGE AND CONTROL TECHNIQUES IN FOREST OF CHINA. Bo-yao Chen (Department of Forestry, Agricultural College of Anhui, Hefei 230036, China)

Among 350 Chinese termite species are Odontotermes Macrotermes, Coptotermes, Hodotermopsis, Nasutitermes Neotermes, Schedorhinotermes, Stylotermes, and Globitermes, which, especially the former 5 genera infest over 300 species of forest trees. In young plantations, especially Chinese fir plantations, where soil is generally prepared and weeds are frequently cleared, soilinhabited termites usually infest young trees, cuttings, and budlings for food constrain, cause death, and control is often necessary. Coptotermes causeslittle damage in plantations, but infests trees nearby houses, sidewalk trees, and valuable old trees in senic spots, where aesthetie value and human wealth are damaged and control is necessary. The distribution patterns of soil inhabited termites are Poison distribution in plantations and negative binomial distribution in separated hilly area with soil shallow to deep downwards. They move in a range 220-660m², which is a noticeble during damage investigation. 1. Control methods for young plantation: (1) Pittfall trap for treating in planting area (2) Mistfumigating termite gallersis; (3) Direct bait trap in forest stands. 2. Soil treatment 0.04% chlorodan in water around yong trees. 3. Control methods for precious old trees, frequent monitering by professional technicians, and spraying dust once finding termites.

#33
REARING OF JAPANESE SUBTERRANEAN TERMITE RETICULITERMES SPERATUS
Hirofumi Watanabe, Hiroaki Noda (National Institute of Sericultural and Entomological Science, Ministry of Agriculture, Forestry and Fisheries, 1-2 Owashi, Tsukuba, 305 Japan)

The Japanese subterranean termites, Reticulitermes speratus (Kolbe) were reared in a small scale.

Pulp-Flock and pine-tree saw-dust were mixed with water and the mixture was filled in disposable small petri-dishes. Twenty termites were settled on the food in each petri-dish and were kept in the moisture controlled box. Inside of the box, relative humidity was kept over 90% with 20% glycerol solution dumped on cotton wool. Under this condition, the termites could survived over a year and produced offspring. Addition of humus from a naturally infested logs caused brown rot on the food and increased the number of offspring.

#34
STUDIES ON THE EFFECTIVE METHODS OF CONTROL TERMITES. Yan-ming Ma (Bengbu Termite Control Institute, Bengbu, Anhui 233000, China)

The termite is one of the serious insect pests in all over the world. The habits of termites indicate that the "flying", "crawing " and " carrying" are the main way for spreading, thus, we must be applied corresponding measures to control them. Applying prevent combine with treat the damage of termites. especially, prevention is better than treat. There are three effective measures to control the termites: 1. when we find winged adults spreading in or outside room, to close the doors and windows right now, to avoid termites spread to around. for controlling invade to room from outside, if the spreading of termites has been completed, we should be applied chemicals to kill termite adults, right now. 2. For controlling termites damage new buildings, we must be applied chemicals to treat the ground basis of new buildings. 3. To control termite sources from other districts introduce the local. Once we find a new kind of termite that it has not find in this local. We must be applied persistent measures to control their reproduction. spreading and damage.

#35
ALLOZYMIC VARIATION AND REGIONAL DIFFERENTIATION IN A PRIMITIVE TERMITE HODOTERMOPSIS IN JAPAN AND CHINA
Tadao Matsumoto, Jiasi Wang (Department of Biology, College of Arts & Science, The university of Tokyo, Komaba, Meguro-ku, Tokyo 153, Japan)

The genus Hodotermopsis is regarded as one of the most primitive termite genera, classified into four species now. In the present study, first, incipient colony was investigated occurs in mature colony or not, allozyme analysis was done. Genotype frequencies were compared between incipient and mature colonies in the Yakushima Island. Further, allozyme patterns were examined on 8 populations, from the Nansei Archiperago, Japan and China. Nei's genetic distanes were calculated among them. The genotype frequencies showed significant difference between mature and incipient colony. This supports the possibility of inbreeding. According to the genetic distance, 8 populations were classified into 3 groups. One of which contains all the Japanese populations, others Chinese ones. This result corresponds to the present classification, but distance value among groups confined to inter-subspecific level. And distances among Japanese populations does not reflect presumed geographical history.

#36
STUDY ON USING ANALOGUE OF TRAIL-FOLLOWING PHERMONE TO KILL COPTOTERMES FORMOSANUS. Fumei He, Junze Luo (Guangdong Entomologic al Institute Guangzhou 510260, China.)

Coptotermes formosanus is the pest around the world. It destroys all the buildings including big hotel made of steel and concrete, injuce forest and seeding nursery. It is more harmful in the tropics & subtropics, because it grows rapidly and is more difficult to control. The economic loss is very serious every year. This is a new way to control C. formosanus using analogue trailfollowing pheromone.

We studied on analogue of trail-following pheromone to kill C. formosanus for two years. The result fully showed that it was effective. The F88 fungus was screened from twenty species. It was extracted by hexane, using dubble circle method. Cultured material, suitable temperature & humidity of the fungus have been studied. Cultured fungus as attractant & killing agent were used. The suitable ratio of water, termiticide, and sugar as well as the form of bait were also discussed.

#37

THE ACTIVITY OF THE VARIOUS PLANTS EXTRACTS TO TERMITE, COPTOTERMES FORMOSANUS SHIRAKI. Hong Huang, Yi Wang, Yunhui Huang, Mingliang Wu, Zhenyou Huang (Guangdong Entomological Institute, Guangzhou, 510260, China)

The termiticidal activity of the extracts from various plants was tested in laboratory. The significant antifeedant activity was observed: the acetone extracts of Tephrosia vogelii Hook f.(leaf), Aphanamixis grandifolia Bl.(bark), Artemisia apiacea Hance(leaf), Tephrosia candida(Roxb) (bark),the methanol extracts of Ficus nervosa Heyne ex Roth(bark), Lygodium flexuosum (L.) Sw.(bark & leaf),Vatica astrosticha Hce.(bark & leaf), Dalbergia odorifera T. Chen(bark), Terminalia arjuna W. et A.(leaf), the ethyl acetate extracts of V. astrosticha, Pteris spp., the petroleum ether extract of Mangifera indica L.(leaf), etc. The antifeeding rates of the extracts (equivalently, 2ml of the extract was derived from 1g dried plant material) were 60.08%-98.94%. The result also showed the methanol extract of Enterolobium cyclocarpum(Jacq.)(bark) as a significant poison against termite. The mortality was over 98% in 7 days after treatment. Some extracts, for example, the acetone extract of Ligustrum lucidum Ait(bark), were found to have a significant stimulating feeding effect to termite.

#38

CASTE DIFFERENTIATION IN THE COPTOTERMES FORMOSANUS SHIRAKI. Liang-wen Huang (Guangdong Entomological institute, Guangzhou, 510260, China)

Caste differentiation in the Coptotermes formosanus is a complex problem. In the lack of primary queen and king, always appear many substitutes. Now, it is not clear how to conduce neotenic.

Author had cultivated a brachypterous neotenic of Coptotermes formosanus from young colony in the laboratory. In the termite colony, every caste has certain number and maintain equilibrim of population. The worker of Coptotermes formosanus is a varient form, it can change to neotenic. also can change to soldier.

Author (1986,1987) had researched on the change of workers to soldiers, in certain colonies, taken out soldiers, the workers (they were fifth instar), soon molted, lost mandibles of workers and became intercastes, for several days it became white soldiers, have moulth apparatus of soldiers, then, white soldiers molt, former mandibles of soldiers was heavily pigmented. After molt again, the mandibles of soldiers were completely black and its head was follow. These were normal soldiers. The changeful speed of workers depended on population density and temperature. When the number of soldiers reached certain rate in the colonies, this velocity of change stopped temporarily.

#39

RESEARCH ON CONTROL OF ODONTOTERMES FORMOSANUS (SHIRAKI) AND MACROTERMES BARNEYI LIGHT IN CHINA. Dong Li, Qi-zhen Rao, Li-ling Chen, Wei-jin Tian (Guangdong Entomological institute, Guangzhou, 510260, China)

Termites Odontotermes formosanus (Shiraki) and Macrotermes barneyi Light are principal insects damaging dikes and reservoirs in South China. Their damage usually generate "a small leak will sink a great ship".

Having studied biological characters, rules of activities and the methods of controlling them for many years, we have obtained satisfactory results technologically and theoretically. For example, the location of the main nests with reference to the distribution of the normal and abnormal holes of the incipient colonies was investigated. The findings can provide us a theoretical basis to locate the main nests. The termites can be effectively killed by using poisonous baits and the growth of the fungus Xylaria nigripes can be a very useful information concerning the location of the nests which can be consolidated.

#40

STUDIES ON TERMITE TRAIL-FOLLOWING IN CHINA. Juntse Luo (Guangdong Entomological institute, Guangzhou, 510260, China)

In China the study on termits trail-following pheromones was started in the end of the seventies (1978), mainly it was carried out in Shanghai, Sichuan and Guangzhou. The sternal glands of the trail-following pheromone secreted by Odontotermes formosanus, the trail-following substance containing hydroxy group and double bond were described. The relevant behaviors in lure-killing O. formosanus and Reticulitermes offinis by means of trail-following pheromones were expounded. Fungus Gloeophyllum trabeum was screened and a series of optimum data favourable to the behavior response and eating of O. formosanus was pointed out in the process of making lure-killing package by use of the above fungus. A complete set of technique for the lure-killing package made by the fungus G. trabeum and the efficient lure-killing method were developed. After the lure-killing package was burried in the ground for a month, Then the O. formosanus and Macrotermes barneyi in all the nests were killed. It was effective for a noticeable trail-following by Coptotermes formosanus to a series of substances. A breach was made on the exposed path of C. formosanus and R. chinensis, termite trail-following pheromon-4-phenyl-ceis-3-buten-1 mixed with shellac and polystyrene was coated on the fibrinous paper so and artificial path was made, the termites could be induced into an attracting box then all the termites could be killed in the nests after a toxicant was administered in the box.

#41

ENTOMOFAUNA OF QATAR:TERMITES AND DAMAGE.Reda M.Adu, (Zoology Department, Qatar University, P.O. Box 120051, Doha, State of Qatar, Arabian Gulf)

Termites are truly tropical insects and live in social communities. There are about 2,000 species included in six families. Termite species in the State of Qatar belong to three families: a) Rhinotermitidae where all members are wood eating and small in size. They are represented by Genus Psammotermes. b) Hodotermitidae where workers collect small pieces of plants in their nests and are known as harvester termites. The family is represented by Genus Anacanthotermes. Damage of living and dead trees in farms, book stores, and houses has been recorded.

#42

CATALOG AND DISTRIBUTION OF TERMITES IN CHINA.Li Gui xiang, Xiao Wei liang (Guangdong Entomological Institute Guangzhou 510260, China)

Termite damage has been recorded for about three thousand years in the ancient Chinese books. Until 1949 Snyder recorded 4 families containing 13 genera and 26 species of termites in China. Tsai et Chen (1964) recorded 62 species. Tsai and Huang (1980) recorded 96 species. Li, Dai et Li (1987) recorded 323 species of 43 genera of 4 families. Huang, Li et Zhu (1989) recorded 361 species of 43 genera of 4 families. This paper recorded 414 species of 45 genera of 4 families in China. Kalotermitidae: 6 genera, 66 sp.; Hodotermitidae: 1 genus, 3 sp.; Rhinitermitidae: 8 genera, 167 sp.; Termitidae: 30 genera, 178 sp.. They have included chinese name, scientific name, time, type locality and range of the distribution. The north distribution limit is about 40^0N (Liaoning: Dandong and Beijing), goingthrough Shanxi, Shaanxi, Gansu to Tibet (Medog 29.5^0N and Cona 28^0N), which is a oblique line from the high (northeast) to the low (Southeast). The southeast of the oblique line is the termite distribution region, but there is no termite distribution in the vast area of the northeast, northwest and Tibet. Distribution of the termite covers approximately 40% of the totel area of the whole country. The northern limit of the distribution of the domidant genera: Reticulitermes 40^0N (Liaoning: Dandong and Beijing); Odontotermes 35^0N (Henan: Luoyang); Coptotermes 33.5^0N (Jiansu: Jianfu), 32^0N (Anhui: Hefei); Cryptotermes 28.4^0N (Shichuan: Jiangan), 27.4^0N (Zhejian: Pingyang); Mound termites 22.8^0N, distribution of Guangxi, Yunnan and Hainan.

#43

FUNGISTATIC ACTIVITY OF SOME EXUDATES OF Anacantho-termes ahngerians Jacobs. (Hodotermitidae). L. I. Ljutikova. (Biological faculty, Moscow Lomonosow University, Moscow, 119899 RUSSIA).

The own metabolites of termites such as various excreta and secrets are included in nest structure. The secret of salivary gland is used by workers for pasting together of soil particles during the building or reconstruction of a nest.The inside of nest passages and living chambers have special coating consisting mainly of lequid and water-free feces of termites. It seems,the secret of salivary, sternal and other glands may be included in composition of coating.We supposed that these metabolites can play certain role in support of fungistatic activity (FA) within the nest. The membrane chamber techniques was used to detect FA in following substrates: filter paper impregnated with excreta, which are released and accumulated during maintenance of termite colony in laboratory; small pieces of filter paper chewed by termites and moisted by saliva; crude extractes of homogenized salivary glands. The three species of fungi were used as targets. The FA express was peculiar to all tested substrates in regard all fungi.The high concentrated extractes of salivary glands showed fungicidal activity that was confirmed by tests on conidia reactivation. These results indicate that fungistasis of nest is conditioned partly by host metabolites which are included in complex of factors responsible for fungistasis as a whole.

#44

Control of Macrotermitinae in forestry in South Africa. P. R. Atkinson, Institute for Commercial Forestry Research, Pietermaritzburg, South Africa. In recent expansions of forestry some 2000 ha annually, of newly planted eucalypts on virgin land, are affected by fungus-growing termites. The main species is *Macrotermes natalensis* Haviland, which extends south on the east coast to nearly 33° S. North of 26° S, *M. falciger* (Gerstäcker) and *M. mossambicus* (Hagen) are also involved; *Odontotermes* rarely. Infestations occur on deep, well-drained soils in warmer (<1300m altitude) drier areas (<900mm rain), comprising rather marginal sites for *Eucalyptus*. Trees are susceptible till canopy formation, most deaths being in the first 6-9 months. In commercial forestry two insecticides are registered for use at planting: chlordane 60% EC, which is still available, applied at 0.6g a.i. in 1l of water per tree poured around the stem; and carbosulfan 10% controlled-release (CR) granules at 1.0g a.i./tree, mixed with the soil at planting. CR granules are replacements for persistent chlorinated hygrocarbons. Carbosulfan proved the most successful out of four a.i.'s tested in CR formulations, appearing to act systemically not by contact. Carbofuran was as good as carbosulfan, is cheaper but, being more toxic, is not commercially available as a CR. Phorate was effective except under dry soil conditions. Chlorpyrifos, the only a.i. acting by contact, was ineffective. *Eucalyptus* species resistant to *M. natalensis* tend to belong to the subgenus Symphiomyrtus, section Maidenaria, series Viminales; susceptible species to the subgenus Monocalyptus. This may be useful for hybridisation or clonal propagation; or for rural afforestation schemes where insecticides may not be warranted.

#45

Natural enemies of Megachile bees*

*: 1- AbbasMirabzadeh
2- Siavosh Tirgari
Iranian Research Organisation for Science & Technology
3- Majid Mashayekhi
Research Organization of Agriculture, Tehran, Iran.

Alfalfa leaf cutter bees (Megachile sp.), essential in alfalfa seed production, are prone to attack by several types of insect pests. The following is the result of the 6 years of research:

1- Parasites: Monodontomerus sp., Melittobia sp. Pteromalus sp., Tetrastichus sp. These minute parasites begin to emerge eight days after transportation of the Megachile bees from the cold store to the incubation room. Their short life cycle and high rate of oviposition make them very dangerous, and they must be eliminated prior to transportation of Megachile bees to the field. Since larae of parasites - Leucospis sp., Coelioxys sp. and Sapyga sp.- normally feed on single bee larvae they are not as dangerous as above ones.

2- Predators: Namognata sp. and Trichodes sp. feed on both larvae of Megachile and the stored pollens in their larval stages.

3- Nest destroyers: Oryzaephilus surinamensis, Plodia interpunctella, Trogoderma spp., Tribolium spp. and Tenebriodes mauritanicus. These pests while searching for nectar and pollens, destroy megachile bee cells, and so kill larvae of Megachile.

STUDY ON THE STORAGE OF SPERMATOZOA IN SPERMATHECA AND FERTILIZATION CHARACTER OF HONEY BEE. Ju-ying Wu (Bee Breeding center of Beijing Academy of Agricultural and Forestry Sciences, Beijing 100093,China)

The sperm of yellow and dark body-coloured drones of honey bee Apis mellifera Linnaeus were collected and mixed in different proportions, and synthetically inseminated to virgin queens. The body color proportions of their progeny workers were calculated. The result showed that there was statistically consistence between the proportions of the progeny workers possessed different body color and sperm from the two drone types. It is indicated that the inheritable characters of drones can be stored and transmitted by the queen to re-express in the progenies.

ASPECTS OF TERMITE RESEARCH IN CHINA. Zi-rong Dai, Gui-xiang Li (Guangdong Entomological Institute, Guangzhou 510260,China)

As far back as 2000-3000 years ago the termite damage had been recorded in the ancient Chinese literatures, but the overall termite research in China mainly has been carried out in last 40 years.

Approximately 400 species termites occur in China from the 25 provinces, municipality directly under the central government and autonomous regions except Heilongjiang, Jilin, Inner-mongolia, Ningxia, Qinghai and Xingjiang.

The genera representative of economic importance are Coptotermes, Reticulitermes, Odontotermes, Macrotermes, Cryptotermes, Incisitermes, Hodotermopsis and Microcerotermes. They cause serious problems in buildings and other timber in service; in dams of rivers and water reservoirs; in plastic cables buried underground; in forests, plantations of trees and so on.

The main centres for termite research in China are scattered over Guangzhou, Shanghai, Beijing, Hangzhou, Nanjing and other cities, belonging to the scientific research institutions, universities and colleges, termite control institutes in the department of housing management. In recent years a great prosperity and advance have been obtained in the area of termite research in China.

AN OBSERVATION ON FACTORS OF EFEECTS ON COCKROACHES CARRYING PATHOGEN. Xiaohuang Dai (Zunyi Medical College, Zunyi, Guizhou 563003, China)

The paper deals with the effects of temperature, habitat, acidity and basicity of intestine, sex on cockroaches carrying pathogen. The cockroaches were captured from four different sources. The kinds of pathogenic organisms depend on the place where the cockroaches inhibit. According to the inspection on the external samples of cockroaches the positive rate of pathogen in hospital are the highest. And the positive rate in internal samples of cockroaches on hospitals and sewers are also higher.

The number of the proteus carried by Periplaneta fulginosa is related to the temperature. The number of proteus increased as the temperature were up. The number of proteus increased from fore-gut to hind-gut. The acidity affected the proteus growth (same temperature).

The difference was obvious in time of eliminated salmonella in gut of P. america related with the temperature. The time for elimination solmonella from gut was significantly shorter in male than that in female cockroaches. The differences in male and female cockroaches. The differences in male and female cockroaches are also consistent with the cetlular number. This average is almost 1.2 time as same as the number of hemocytes in females.

A STUDY OF ACTINOMYCETES METABOTITES ON TERMITE CONTROL. Ruyin Xu. Dezhao Jiang (Hangzhou Termite Control Institute, Hangzhou 310006, China)

The article is introduced about the control effect of " 7051 " preparation, metabolic product of actiomycetes, on Raticutitermes flaviceps and Coptotermes formosanus. Three years' indoor and outdoor tests proved that the " 7051" is a stronger stomach and contact insecticide killing termite. Through indoor experiment it proved that its control effect is over 95% to Raticulitermes flaviceps, and the effect of the open field is over 84.4%. "7051" is of charactors: no pollution to the surrounding, being used conveniently, cheapness and high effect. It is an ideal poison of comprehensive control termite.

TEST OF TOXICITY OF KOTHRINE MIXED POWDER ON COCKROACHES. Siwei, Gao, Dezhao Jiang, Meijing Zhang, Ruyin Xu (Hangzhou Termite Control Institute, Hangzhou 310006, China)

The test of toxicity of complex powdere of kothrin wettability powder mixed with tsumacide powder by proper rate on cockroaches was carried out. It can delay resistance of cockroach to pesticides in order to get to high effect and low mammalian toxicity.

Indoor test shows that LD of the Double-Poison coefficient of co-toxicity for killing Periplaneta amercana is 164.0, Knocdown Time (KT) is 14.5 minutes. The result shows that the efficacy of double-poison is 4 times as that of using kothrine only. In the outside, using 1% complex power 10g/m, KT is 30 minutes to Blattela germanica, the efficacy can obtain above 90% within month.

RESEARCHES ON USING WAY—8202 TERMITE BAIT TO WIPE OUT THE TERMITES IN THE DAMS OF 113 RESERVOIRS. Yi—an Wang(The Institute of Zhejiang Linan Termite Control,China)

Abstract,The long—term and wide scope use of WAY—8202 termite bait to control the Odontotermes formosanus in the woods has proved that the effectiveness is of great satisfaction. Nevertheless,can it be used to wipe out the termites perching in the earth—built dam of the reservoir to which a menace has been constituted? No reports on this subject have been seen. This paper reports the trials of applying WAY—8202 termite bait to the dams of 133 reservoirs and 106—kilometrelong river dikes in the 3 provinces of Zhejiang,Jiangsu and Guangxi to wipe out the dam termites. The results of the trials have proved that the effectiveness is also in the affirmative. This method avoids many shortcomings,such as great labour costing,much investment,the damage to the dam and hard to carry out in an all—round way,which exist in the common methods,namely,nest digging,poisonous gas fumigation and poisonous soil grouting;so this method is considered by the administrative personnel of the hydraulic engineering projects as the first—selected bait to control the termites in the dams at present.

WAY—8202 termite bait consists mainly of insecticide,attractant,synergist and digestive. It is the suitable time to apply the bait when the average daily temperature is 20—30 degrees centigrade. The most suitable temperature is around 25 degrees centigrade. After the termites have eaten the bait,Yylaria nigripes can come up from the surface of the top and the slope of the dam,which are the characteristic indicators appearing on the surface of the dam after the colony of Odontotermes formosanus have died. They are also the important basis for testing and verifying the effectiveness of the bait. If the Yylaria nigripes can't be found on the surface of the dam, the effectiveness may be judged by the increase or decrease in the activities signs of the termites compared with before applying the bait.

STUDIES ON CONTROLLING OF TERMITES WITH THE CHINESE MEDICINAL HERB BAITS Shu-qing Lin (Termite Research Center of China, Hangzhou, Zhejiang 310011, China)

The Chinese Medicinal Herbs is one of the richest treasure resources. Not only has it been in a long history to control insect pests, but also has been accumulated the wealth of experience. In the early of 70's, the experts in Zhejiang and Jiangshu provinces started to control termites with smoky agents of Chinese Medicinal Herbs, which were also processed into liquid forms sometimes. They achieved some success, but didn't make a thorough investigation and study. In order to raise the efficiency of controlling termites, the auther tried to study the termite baits.

Based on the identification of many kinds of plants to control termites in the laboratory and the field, many kinds of Chinese Medicinal Herbs, e. g. Tripterygium wilfordii Hook. f., Phododen molle (Bl.) G. Don and Macleaya cordata (Willd) R. Br. were selected. In addition, Chinese Medicinal Herb Baits were prepared from these plants, additives and some materials from termite nests. The bait not only can increase the efficiency of controlling termites and the feeding rate, but also has no environmental pollution. The tests of toxicity in the laboratory showed that the half-lethal-time was 126 hours for Coptotermes formosanus Shiraki. The tests in the field showed that the whole nest would be extinguished in two months after the termites ate the baits. But sometimes it would be affected by the environmental weather. In addition, after tests in the laboratory and the field, the desirable packing material was screened to improve the efficiency of controlling termites.

PRILIMINARY STUDY ON SPECIES AND DISTRIBUTION OF TERMITE IN HUANGSHAN MOUNTAIN. Zhen Chen, Yong Xu (Wuhu Institute of Termite Control, Anhui 241002, China)

This essay deals with the species and distribution characters of termites in the regien. There are two families, Six genera, Seventeen species in Huangshan Mountain. Among them Mirarasvititermes sp. belongs to a new family. Mirarasvitermes sp. Nasutitermes parvonasulus Reticulitermes couns, R. danluensis are first recovered species in Anhui Province. It's obvious that Termites of Huangshan Mountain is distributed vertically. Distribution of termites Coincides with that of vegetation: 1. Below 500 metres above sea level, there are only six termite species recorded. 2. Termite species are fairly abundant amount 500-900 meters above sea level. There are as many as eleven species of termite. 3. There are only five species of termites among 900-1250 meters above sea level. 4. Because there is intact vegetation on North slope. Termites are regularly distributed. Besides the above-mentioned regular distribution pattern. distribution of termites in Huangshan Mountain also possesses the speciatities: a) The highest distribution of termiter is at 1000 meters above sea level. b)Although vegetation is abundant on North slope, there are only three families of termites. c) Distribution of termites of Nasutitermes and Mirarasvititermes is limited and is only distributed around Yungushi Temple.

INVETERATE ENEMY OF SUBTERRANEAN TERMITES-DORYLUS ORIENTALIS WESTWOOD. Shi-cai Yin (Hunan Institute of Forest Science, Changsha 410004, China)

Dorylus orientalis Westwood is an important natural enemy of Odontotermes formosanus Shiraki and Macrotermes barneyi Light. This species of ant has high adaptability and agrees with both light and dark. therefore, it can adapt itself to the dark condition in the termite tunnel. We found, by anatomising the termitarium, that once the ants had come into trunk tunnel the termite colony had certainly been preyed upon by the ants as their nest. Studies on utilizing the bones of pigs and fish as a bait to allure the ant to control the two species of termite. This method to control termites, will be economic and easy to conduct in the future. It's hopeful to be a sominant control measure.

ON EXISTENCE,DISTRIBUTION AND DAMAGE OF TERMITES IN GUIZHOU PROVINCE.Qi-sheng Qiu (Guiyang Station of Termite Control, Guiyang, China)

1. The climate condition and the existence of termites

In Guizhou Province, subtropic zone covers four fifths and the average temperature of a year is 10 ℃ to 20 ℃; the average temperature in January is 4 ℃ to 6 ℃, and July 17 ℃ to 28 ℃.

The climate condition in Guizhou suits to the existence and propagation of termites.

2. Termites species and their geographical and vertical distribution.

The termites include 74 species belonging to 5 families, 14 genera (Termopsidae 1 species, Kalotermitidae 5 species, Stylotermitidae 6 species, Phinotermitidae 34 species and Termitidae 28 species) which are distributed in 62 counties with the elevation of 200-1620 meters.

3. A survey of damage

By examining 39 counties, the damage rate was found to be 60 to 70 percent in serious damaged areas (generally, from 35 to 40 percent). Damages were caused by Coptotermes, Reticulitermes, and people suffered serious economical losses.

OBSERVATION ON BEE MITE-RESISTANT CHARACTER OF CHINESE BEES. Zhongpu Li (Beekeeping Institute of Linxiang County, Hunan 414300, China)

I have tried to raise Chinese bees and Italian bees in a same honeycomb. The bee mites in the mixed bee colony will disappear by themselves without any preventive measures, and the new varroa under woodi in Chinese bees also will disappear by themselves in the strong colony. It is proved in experiments for many years that when Italian bee drone with mites and mite ovum are placed in the Chinese bee colony, acaridiasis will disappear automatically. According to preliminary observation, I consider that the biological character of th mite-resistance of Chinese bees are: 1. The forelegs and hind legs o. Chinese bees can inertially and physically clean down its whole body, so that the mites will be seized. 2. The ovum of greater and lesser wax moths have special protection smell, and mite ovum has no this smell, so that the mite will easily be distinguished and bit off by Chinese bees with keen sense of smell. 3. The smell of Chinese bee colony is not well for the mites. 4. Chinese bees have particularity in treatment and clean down of comb drone where the mite easily breed.

TEST OF THE INCREASE PRODUCTION OF THE RAPE SEED POLLINATED BY HONEYBEE. Zhongpu Li, Shu Wu (Bee Product Research Center of Hunan Province, Linxiang 414300, China)

In six counties of Hunan Province, the conditions are different in the topography, the climate, the soil, the variety of Rape, and the management method. We tested about 153 ha Rape which was pollinated by honeybee.

Test design: In a county, it was necessary that the variety of rape, the breeding seedlings, the transplant, the soil, the drainage and the irrigation, and the management should be almost the same,conditions. we compared the fields which had bees and the fields which had no bees. The compared fields which were 20 km from each other. In the fields which had bees, there was one colony of honeybees near the Rape in about 0. 2 ha.

Test items: The total production, the average production the one-thousand seed weight, the producing oil rate.

Result: The increase production were maximum 40.8% and minimum 20.8%. the average increase production was 27.2%. The one thousand seed weight increased 12.5%. The producing oil rate increased 10.2%. The benefit of the increase productions that the crops were pollinated by honeybees was certain.

A REVISIONARY LIST OF CHINESE ANTS (HYMENOPTERA: FORMICIDAE). Jian Wu, Changlu Wang (The Research Institute of Forestry, The Chinese Academy of Forestry, Beijing 100091, China)

The first list of Chinese ants was presented by W. M. Wheeler in 1930-31, based on the work of some myrmecologists from 1850 to 1930. In his list, 245 species, subspecies and varieties were recorded from China excluding Taiwan. During the recent ten years, we have carried on a series taxonomic studies on the following genera: Camponotus, Formica, Polyrhachis, Prenolepis, Paratrechina, Acropyga, Tetraponera, Gnampotogenys, Tetramorium and Vollenhovia, from which a lot of new species, many new synonyms were reported and some subspecies and varieties were elevated to specific rank. 398 species, subspecies and varieties belonging to 77 genera, 8 subfamilies from China, including Taiwan, Hongkong and Macao are given in this paper. A key to the genera of Chinese ants are presented.

POLYMORPHISM AND STERILE CASTE POLYETHISM IN TWO INDIAN TERMITES. P.K. Sen-Sarma (Presidency College, Flat No.1, 2nd Floor, West Block, 302, N.S.C. Bose Road, Calcutta - 700 047, India) S. Kumar (FRI, Dehra Dun, India)

Ploymorphism and caste polyethism in *Microcerotermes beesoni* and *Odontotermes obesus* have been described and discused, Polymorphic forms were determined based on morphometric measurments of head-width, antennal length and number of segments, 3rd/4th antennal segments length and metatibial length. Caste polyethism was ascertained by meticulous observations on foraging nest repair, mud plaster/gallery repairs and expansion, nest expansion, inner nest duties, queen attendance and eggs tending and swarming sites attendance. Differences in job allocation among polymorphic worker forms were analysed using X^2 test for heterogenecity. Participation of workers and soldiers in queen attandance, foraging and swarming was analysed using Man-whitney rank order test. Spearman's correlation coeffient was used to evaluate changes in worker types in time span at swarming sites.

THE NATURAL SUSCEPTIBILITY OF FOURTEEN WOOD SPECIES AGAINST THE DRY-WOOD TERMITE *CRYPTOTERMES BREVIS* (WALKER). (KALOTERMITIDAE, ISOPTERA). S.I.M. Moein (Plant Protection Research Station, EL-Sabahia Backoos 21616, Alexandria, Agric. Res. Center, Egypt)

This study concluded the susceptibility of fourteen wood species (Ten local and four imported) against the attack of the dry-wood termite *Cryptotermes brevis* (Walker). The mortality means were increasing and wood consumption means were decreasing linearly during the six weeks.

The susceptibility of the tested wood species could be arranged according to the range of the mortality ratings; within which individual wood-species were arranged according to wood consumption ratings as follows: I. Very susceptible: where *P. glauca* > *P. abies*; II. Susceptible: rated in the order *F. sylvatic* > *C. glauca* > *S. babylonica*; III. Intermediately susceptible: This group of the tested wood-species could be sub-divided into two sub-groups: (A) Moderate intermediately susceptible: The susceptibility order could be rated as *D. sissoo* > *C. sempervirens* > *M. alba* > *F. sycomorus*, (B) Low Intermediately susceptible: where the susceptibility order was *A. nilotica* > *T. disticum* > *A. lebbeck*; IV. Low susceptible: The susceptibility order was *P. silvestris* > *E. camaldulensis*. The linear relations for each of means of mortality and wood-consumption amounts, For every group of wood-species, were calculated.

DNA Fingerprinting with oligonucleotides in honeybees (Apis mellifera L.)

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Because of the multiple mating of the honeybee queen (*Apis mellifera*) intranidal relationships among the members of honeybee colonies are of interest for many sociobiological and evolutionary biological problems. Phenotypic mutants and isozyme markers have been used to identify patrilines in bee colonies. However, these techniques can be only efficiently used in combination with artificial insemination. Furthermore the degree of variability is low and only as much as eight coexisting patrilines have been tested so far. Isozyme variability is too low to reveal sufficient polymorphisms for patriline discrimination in colonies with naturally mated queens. Here we present a technique where we use synthetic oligonucleotides for DNA fingerprinting. With routine molecular biological techniques it is easily possible not only to discriminate between worker bees of different patrilines but also to study in detail the still poorly documented degree of polyandry of the queen.

ECOLOGICAL GENETICS OF ENTOMOPATHOGENIC NEMATODES. Randy R. Gaugler (Dept. Entomology , P. O. Box 231, Rutgers University, New Brunswick, NJ 08903 USA)

Expanded use of entomopathogenic nematodes in biological control cannot be expected unless field efficacy is increased. The current " efficacy gap " between nematodes and chemicals might be bridged by matching nematode species and strains against those insects they are best adapted to parasitize. This approach requires understanding the adaptive nature of entomopathogenic nemtodes, particularly how they locate, identify,and assess potential hosts. Clearly, no single species or strain, including the all strain of S.carpocapsae,will be effective against all insect pests. This would be analogous to planting one wheat variety in all habitats. S. carpocapsae will be most useful if the target insects highly mobile at or near the soil surface,or if the host is highly susceptible to infection (e. g., black vine weevil). Genetic improvement is a viable approach to improving efficacy but can not be expected to overcome poor adaptability. Attention must also be given to protecting the genetic variability of new isolates, preventing the loss of alleles that lead to laboratory adaptation. Finally, it is essential that prediction models be developed that allow nematodes to be used only when and where they are likely to be effective.

FACTORS AFFECTING THE PATHOGENICITY OF ENTOMOPATHOGENIC NEMATODE INFECTIVE DAUER LARVAE. Christopher Z. Womersley (Department of Zoology, Univ. of Hawaii at Manoa, Honolulu, HI, 96822, U.S.A.)

Very little is known of the factors that affect the pathogenicity of infective dauer larvae of entomopathogenic nematodes. It has been assumed that outside the host in the soil environment the physiological fitness of dauers (as measured by available food reserves) will play an important role in quiescent survival during host absence. No dauers have been able to survive cryptobiotically. However, all dauers released from the host may not be equally physiologically fit, since there are different generations involved. We are also unaware as to whether quiescence and/or cryptobiosis are the only modes of dormancy during host absence or whether a diapause phenomenon exists. Preliminary observations infer the latter in some cases and suggest that not all dauers in a given population are capable of this response. Like cyst nematodes there may be a mixture of dormant conditions that allow slow release of dauers into the active state, but all may not be immediately pathogenic on revival. Ultimately, those factors involved with the correct development of the dauer within the host (i.e. host physiology/ biochemistry, time of production) will affect the behavior of the dauer outside the host and thus will have the greatest effect on pathogenicity. Thus, although the production of large numbers of dauers on exotic hosts or in culture poses no problems the quality of the dauer produced (in terms of pathogenicity) may be different from that obtained using the natural host. In many cases natural hosts have still to be identified.

IMPORTANCE OF PHAGES AND BACTERIOCINS OF *XENORHABDUS* SPP. FOR THE SPECIFICITY OF THEIR BACTERIAL HOST TO THE NEMATODES STEINERNEMATIDAE AND HETERORHABDITIDAE. Noël BOEMARE (Laboratoire de Pathologie comparée INRA-CNRS. Université Montpellier II, 34095 MONTPELLIER CEDEX 5, FRANCE)

Bacteriocins occur naturally in few quantities in the two phases of *X.nematophilus*, *X.bovienii*, *X.poinarii*, *X.beddingii*, *X.luminescens*, symbionts of *Steinernema rara*, *Steinernema intermedia* and strain Q1 of unnamed entomopathogenic nematode. Bacteriocins and phages were evidenced in greater quantities after induction by mitomycin C or temperature causing the death of the producer cultures, except those of *X.luminescens*. Bacteriocins of one *Xenorhabdus* inhibit the growth of closely related bacterial species, and of the other *Xenorhabdus* spp. Sensitivity to the bacteriocin suspensions is eliminated by pronase E or heating (100°C, 30 min). The synergistic effects of these bacteriocins produced by both phases, and the previous identified watersoluble antibiotics only produced by phases one, establish the monoxenic conditions observed during the parasitic development of the host nematode into insect cadavers. Bacteriocins probably participate strongly to prevent any foreigh candidate to combine with the normal host nematode of their producer bacteria.

NUTRIENT FUNCTIONS OF *XENORHABDUS LUMINESCENS* ISOLATES Richou Han, Liying Li (Guangdong Entomological Institute. Guangzhou 510260, China)

Seven *Xenorhabdus luminescens* isolates tested showed differences in their suitability as a nutrient for a particular *Heterorhabditis* population. None of the *Heterorhabditis* strains developed on all bacterial isolates. The symbiont of *H. megidis* seemed to be the most universally acceptable nutrient for nematode development. All *Heterorhabditis* strains tested were able to reproduce on it. These *X. luminescens* isolates also influenced the growth rates and yields of the nematode strains and might support higher yields for others than for their associated nematodes. Free amino acid compositions and concentrations of these bacterial cultures in a soy flour-egg medium varied. which probably reflected the difference in the nitrogen metabolism of *X. luminescens* isolates. Whether alterations in these nitrogenous compounds are correlated with the specific nutrient supply of the bacteria for *Heterorhabditis* nematodes will be discussed.

FREEZE-DRYING *Xenorhabdus nematophilus* FOR THE MASS CULTURE OF *Steinernema carpocapsae*. Li-hong Qiu (Guangdong Entomological Institute. Guangzhou 510260. China) and R. J. Akhurst (CSIRO Division of Entomology. GPO Box 1700. Canberra. ACT 2601. Australia)

The influences of a number of factors on the freeze-drying of the *Xenorhabdus*. spp.. bacteria symbiotically associated with the entomopathogenic nematodes *Steinernema* and *Heterorhabditis* were examined. There was no significant loss of viable cells arising from centrifugation (5000 rpm. 15°C. 12 mins) and resuspension in cryoprotectant. the growth media tested had no significant effects on the viability of free-dryed *X. nematophilus*. However. there were significant differences between cryoprotectants, cell concentrations, vacuum conditions and reconstitute conditions. Protocols for freeze-drying *Xenorhabdus nematophilus* were defined. The protocols were applicable to *X. bovienii* strain T319 and *X. luminescens* strain C1 and strain HP88.

Each vial of 0.5 ml freeze-dried cells can be used to prepare either 10L inoculum in a one-step process (50*0.01ml into 200 ml LB for 48h) or 50L in a two step process (5*0.1ml into 200ml LB for 24h then 2*100*2ml into 200ml LB for a further 24h). No contamination organisms or phase change were detected from reconstituted freeze dried cells.

RESEARCH AND DEVELOPMENT OF FIRST COMMERCIAL VIRAL PESTICIDE-HELIOTHIS NUCLEAR POLYHEDROSIS VIRUS PESTICIDE IN CHINA. Guang-yu Zhang(Wuhan Institute of Virology, Academia Sinica, Wuhan, Hubei,430071, China), Chuan-zhen Bai (Jianghu Farm, Hubei,431725, China)

About 16 yr from its initial isolation, laboratory research, field test to industrial production, H.armigera NPV has been developed into a commercial viral pesticide. It is the first time in China that technical success in the study of an insect virus has been translated into commercial success. It is the foundation of the whole production technology that palstic rearing trays of individual cells, containing semisynthetic diet are used as mass-rearing of larvae and virus-propagation. The major production procedures are operated by machinery. There are two kinds of formulations, wettable powder with 2×10^{9}PIB/g and emulsion with 3.2×10^{9}PIB/ml. Both of them contain various adjuvants. In resent years, the output of the viral pesticide and used area have being grown substantially. Since 1987, the 24 tons of the viral pesticide have ben produced, and applied to a total area of 0.6 million mu. In 1991, the 12 tons were produce, and applied area was 0.3 million mu. About 80% of all used area was for control of H.armigera of cotton, and others were used to control H.armigera and H.assulta on tobacco, cayenne pepper and tomato. In general, the effectiveness of the viral pesticide was equivalent to that of standard pyrethrins, and superior to that of OP-insecticides and carbamates.

THE PATHOLOGICAL CHANGES OF PERITROPHIC MEMBRANE OF TWO INSECTS INFECTED WITH NPV AND CPV. Ta Deng, Xiu-yu Cai, Tsuey Ding (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The peritrophic membrane(PM), which lines the midgut of many insect species, may serve as a mechanical barrier to invading microorganisms. It was found that the PM of both Agrotis segetum and Heliothis assulta underwent remarkable pathological changes after infected with nuclear polyhedrosis viruses (NPV) and cytoplasmic polyhedrosis viruses(CPV). The PM of A. segetum infected with CPV became much thicker than that of the healthy ones in contrast to no morphological change in the PM of the NPV-infected larvae. There were three new proteins of the PM appeared on SDS-PAGE as the result of NPV infection. However, the infection of CPV resulted in a remarkable different SDS-PAGE pattern. The electron micrograph showed that there existed virions and polyhedras in the CPV-infected PM. The PM of H. assulta gradually became thicker, more opalescent and more fragile after infection of NPV and CPV. Several new proteins were found in CPV-infected PM in contrast with no new protein appeared in NPV-infected PM. It was also found by electron microscopy that some occluded substances with different sizes existed in NPV-infected PM and became more and more, larger and larger with the development of infection.

CHARACTERISTICS OF A STRAIN OF NUCLEAR POLYHEDROSIS VIRUS SELECTED FOR AN INCREASED RATE OF VERTICAL TRANSMISSION. James R. Fuxa and Arthur R. Richter (Department of Entomology, Louisiana State University Agricultural Center, Baton Rouge, Louisiana 70803 USA)

When LC_{50} dosages of wild isolates of Spodoptera frugiperda (Sf) nuclear polyhedrosis virus (NPV) were fed to 5th instar Sf, the surviving insects transmitted the virus to 14% of their progeny. A strain of NPV was selected for an increased rate of vertical transmission. When LC_{50} dosages of the selected virus was fed to 5th instar Sf, the survivors transmitted the virus to 23% of their progeny, which was significantly ($P<0.05$) higher than with the wild NPV. Of these infected progeny insects, 57% were killed and 43% survived to the adult stage with nonlethal infections. When the wild virus was vertically transmitted, 38% of the infected insects were killed and 62% had nonlethal infections. The LC_{50}s of the wild and selected NPVs in 1st instar Sf were 2.0 and 4.0 polyhedral inclusion bodies (PIB) insect, respectively, and in 5th instars the LC_{50}s were 3.0 X 10^7 and 3.1 X 10^7 PIB/707 mm^2 diet surface, respectively. Differences were detected between the wild and selected strains of NPV when the viral DNA was digested with the restriction enzymes EcoRI, HindIII, and BamHI. In another experiment, survivors were reared for 5-7 generations without further exposure to virus. The percentage infection by the wild NPV declined from 13.8% of the insects in the 1st generation after exposure to 3.3% in the 5th generation, whereas that by the selected NPV declined from 18.8% in the 1st generation to 12.1% in the 5th and 9.8% in the 7th generation.

SYNERGISTIC ASSOCIATION OF A NUCLEAR POLYHEDROSIS VIRUS WITH OTHER TYPES OF INSECT VIRUSES. Tosihiko Hukuhara, Jinhua Xu (Faculty of Agriculture, Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183, Japan).

In studies on nuclear polyhedrosis virus (NPV) infection in the common armyworm, Pseudaletia separata, we noted that the NPV infectivity was enhanced by factors present in the capsule of a granulosis virus (SyF) and in the spheroid of an entomopoxvirus. The presence of the factors in the inoculum reduced the median infectious doses of NPV by several thousand times. The factors differ from each other in molecular weight and antigenicity. SDS-PAGE of the SyF and the factor from the spheroid yielded one major band of 98-kDa and 38-kDa, respectively. The SyF was adsorbed to viral envelopes and to the surface of microvilli. Specific ligand-receptor interaction would seem to be a prerequisite for the enhancement. The adsorbed SyF may interact with the bilayer membranes in such a way as to increase a membrane fusion event.

LARGE SCALE PRODUCTION OF BACULOVIRUSES *IN VITRO* Just M. Vlak (Department of Virology, Agricultural University, Binnenhaven 11, 6709 PD Wageningen, The Netherlands)

Baculoviruses are insect pathogens which are successfully used as biological control agents of insect pests in agriculture and forestry as alternatives to chemical insecticides. In the last decade, these viruses have also been successfully developed as vectors for the expression of foreign genes in a eukaryotic environment. Large amounts of baculoviruses and recombinant protein are required to meet the needs of the user. Therefore, it is important to have cheap, simple, efficient and reliable production systems. Baculoviruses and recombinant proteins can be produced in insect larvae as well as in cultured insect cells. In this contribution the potential of insect cells in large-scale culture will be reviewed. Recent advances in the area of medium development and bioreactor configurations will be discussed, as well as other important parameters important for optimal baculovirus production, such as the choice of cell lines. Special emphasis will be given to continuous production systems of (recombinant) baculoviruses in two-stage bioreactors and to the potential of insect cell cultures to produce authentic recombinant proteins. The question will be addressed whether these proteins are chemically, immunologically and biologically similar, if not identical to their authentic counterparts.

REPLICATION OF NUCLEAR POLYHEDROSIS VIRUS SINGLY EMBEDDED OF THE COTTON BOLLWORM? Heliothis armigera, (HaSNPV) IN FOUR CELL LINES AND THE IN VITRO SYNTHESIS OF ITS BIOMACROMOLECULES. De-ming Su, Jing Zhang (Fudan University, Shanghai 200433, China)

Four cell lines were used to investigate their permissiveness to Heliothis nulcear polyhedrosis virus (singly embedded) (HaSNPV): Heliothis armigera cell line HA-8212, Spodoptera frugiperda Sf cells, Ectropis obliqua cell line, SIE-EO-803, and Chinese Hamster cells CHO. Typical cytopathologic effects (CPEs) were observed in HA-8212 cells and polyhedra produced in the nucleus. Although most of the Sf cells disintegrated 12 h postinfection no polyhedra was formed. The other two cell lines, SIE-EO-803 and CHO, showed none of CPEs after virus infection. TCID50 assay of infected cell medium showed virion activity in HA-8212 cells, and production of virions detected by ELISA of both Mab and polyclonal antisera of HaSNPV. HaSNPV-DNA synthesis was found to be complete in HA-8212 by dot hybridization, partial in Sf and SIE-EO-803, and none in CHO protein synthesis of virus in both HA-8212 and Sf cells were studied by 35S-Met labelling. 10 ICSPs were detected in infected HA-8212 cells but none in Sf cells. In addition, the synthesis of ICSPs in HA-8212 cells was completely inhibited by cycloheximide.

DEVELOPMENT OF A ENGINEERED INSECTICIDE EXPRESSING BT TOXIN PROTEIN BY RECOMBINANT BACULOVIRUS IN SF CELLS. Yipeng Qi, Youngxui Huang, Xifei Pei, Ying Shen (Dept of Virology, Wuhan University, Wuhan 430072, China)

Polyhedrin gene (ocu) of Buzura suppressuria NPV (BsNPV) is mapped on 5′ end of BamHI-H fragment. A transfer vector, pBsA39, has been constructed with the H fragment, pBR322 and polylinker. The HindIII-6.6 kb fragment, in which the delta crystal gene (cryIAc) from Bacillus thuringiensis (Bt) HD-73 contains, from plasmid pBt28 was subcloned into pBsA39 on HindIII site of polylinker and controlled under ocu promoter. The cry gene on polyhedrin-minus recombinant pBsBt101 is able to express two proteins with MW of 68 kd and 23 kd in E. coli cells, and with biological function according to toxicity to cabbage caterpillar larvae. In addition, pBsBt101 DNA was co-transfected with wild-type AcNPV DNA into SF cells. Polyhedrin-minus recombinant virus, vABBt101, was obtained in 7-14 days because of homologous recombination in vivo. A protein with MW of ca. 85 kd is expressed. Biological toxicity of recombinant baculovirus to 3rd instar larvae of T. ni shows significant increase in mortality (100%) and decrease in speed to kill (4 days pi) compared to wild type AcNPV (88% in 6th day pi). It is demonstrated for posibility that recombinant virus is a potentail genetically engineered baculovirus insecticide.

VIIIS-3 The Insect Cytoplasmic Polyhedrosis Viruses

INTRODUCTION: IMPORTANCE OF THE CYTOPLASMIC POLYHEDROSIS VIRUSES IN ENTOMOLOGY. Serge Belloncik (Institut Armand-Frappier, Université du Québec, Laval, Canada). and Su DeMing (Fudan University, Shanghai, China.).

Cytoplasmic polyhedrosis viruses (CPVs) are frequently isolated from insects collected in the field or reared in the laboratory. These viruses are studied in some laboratories around the world for mainly two reasons:

1. The CPVs are contaminants of various insects. They can contribute to important economically losses in the silkworm industry and, by the vertical transmission, persistence and a possible latency in an insect population, the CPV infection affects not only the quantity of insects reared in the laboratory for various entomological studies but also the physiology of these insects which could alter the results obtained during these studies.

2. The CPV infection in an insect population is, in general, chronic rather than epidemic and the CPV is less lethal for an insect than a baculovirus. For these reasons the CPV's received less attention than the nuclear polyhedrosis viruses in biological control programs. However, in the recent years the demonstration of the importance and advantages of the CPV's as long term biological agents were demonstrated

We will attempt during this symposium to cover several research fields in order to update our knowledge on different aspects of the cytoplasmic polyhedrosis viruses with an emphasis on the recent achievements in the biological and molecular biology and genetic engineering fields

PATHOGENESIS OF THE CYTOPLASMIC POLYHEDROSIS VIRUS. Shigetoshi Miyajima (Faculty of Engineering, Mie University, Tsu, Mie 514, Japan).

The purpose of this section is to summarize some studies on the problems concerning the viral (CPV) infections of the silkworms that are now becoming to investigations; that is,

(1) High sensitivity was observed when the CPV was injected into posterior part as compared with when it was injected into anterior part of the silkworm.

(2) Resistance to the CPV of silkworm, reared on artificial diet containing inactivated CP was examined. When the larvae reared on artificial diet containing CP inactivated by heat treatment, were perorally inoculated with CPV, the incidence of cytoplasmic polyhedrosis was significantly reduced.

(3) It was demonstrated that co-infection with a large amount of non-pathogenic bacteria, led to increase of incidence of cytoplasmic polyhedrosis. The synergetic effect of bacteria was lost by addition of antibiotics.

(4) The silkworm larvae treated with sublethal dose of some insecticides were more susceptible to peroral infection with CPV than the larvae non-treated with insecticides.

(5) In the case of oral inoculation with CPV to the 5th instar larvae, refractive index in the hemolymph showed lower hemolymph values as compared to the healthy larvae, and from 4 days later the difference increased.

PINE CATERPILLAR CONTROL BY DENDROLIMUS CYTOPLASMIC POLYHEDROSIS VIRUSES IN CHINA. Chang-jie Chen(Division of Entomology. Forest Research Institute, Chinese Academy of Forestry, Beijing 100091, China)

It has been demonstrated by the study and practice in the last decade that Dendrolimus CPVs(DCPVs) is one of the most effective means in the integrated management of the pine caterpilars, the Chinese No.1 forest pest occuring in about 2. 66 million ha. of forests yearly. Up to now, sereval strains of DCPVs, classified as three types of RNA genomes and proved safe to vertebratesm, have been isolated from the larvae of Dendrolimus spp.. But the isolates mainly used on large scale in China are the mixture of two types of DCPVs. Although the target tissue infected is limited in epithetial midgut cells, the differences between healthy & infected larvae are significant. The average of frass, larval weight and pupal weight of infected larvae were 32.1, 7.7 & 1.6 times lower than those of healthy larvae respectively. The emergence rate and the egg mass of the infected insect reduced by 71.4% and 65.5% respectively, and the ratio of female to male also decreased to certain extent. Furthermore, the polyhedra of DCPV on the egg surfaces, observed through the SEM, resulted in the infection rate of newly hatched larvae as high as 55.9% . At present, the most economic and effective way to produce massive DCPV is by inoculating high population density of larvae in stands with DCPV. The polyhedra harvested from a single larva amounted to more than 200 million after the procedure of granding, filtering and certrifugating, in which the rate of recovery was above 80% . The larvae under the 4th instar per ha. could be effectively controlled with 75 to 300 billion of the polyhedra, leaving over 70% mortality. However, the best strategy is to control the generation before overwintering by ground or air spraying with ultravolume of oil emulsion of DCPV pesticide. Statistically, 28000 ha. of forests in China has been controlled with DCPV-pesticide.

A STUDY ON THE ELECTROPHORETIC GENOME PROFILES OF THE CHINESE STRAINS OF DENDROLIMUS CYTOPLASMIC POLYHEDROSIS VIRUSES. Liang Tao, Chang-Jie Chen, Zhi-xian Wang and Jia-wen Chen (Division of Entomology, Forest Research Institute, Chinese Academy of Forestry, Wan Shou Shan, Beijing, 100091, China)

This paper investigates the genome profiles of the Chinese strains of Dendrolimus cytoplasmic polyhedrosis viruses (DCPVs) which is one of the most effective means in integrated management of Dendrolimus spp.. The genomes of DCPVs were examined in 3% disc PAGE system which was not only suitable for classification, but also effective to detect the intra-type variations if the gel was stained with ethidium bromide. Based on the electrophoretic patterns of genomic dsRNA, it can be concluded that there were three genomic types of DCPVs infecting the larvae of Dendrolimus spp. in China, and any possible combinations of the three types of DCPVs could mixedly infect the pest. It has been found that possible latent CPVs were induced in the larvae of Debdrolimus punctatus or Heliothis armigera by inoculating DCPVs, this finding indicates that some larvae which look healthy in lab or in Nature might have been latently infected with CPV. Another finding is that the molar proportions of RNA segments in genome profiles of some mixed CPVs were always stable, this implies that these mixtures of CPVs might have a solid-relationship, therefore it could be hypothesized that some mixed CPVs were symbitic during their replications. These findings suggest that the further research into latent and mixed CPV-infections be worthwhile.

CYTOPLASMIC POLYHEDROSIS VIRUS REPLICATION *IN VITRO* : Virus-cell interactions. Serge Belloncik (Institut Armand-Frappier, Université du Québec, Laval, Canada).

The first characterizations of the cytoplasmic polyhedrosis viruses (CPVs) were limited to the structural, biochemical and pathogenesis of these double-stranded RNA viruses during their replication in an insect. However, the development in the recent years of several suitable cell lines which support efficiently the replication of several CPVs permitted a further characterization of the replication and the molecular structures of these viruses.

Results of experiments, conducted using different cell lines and CPVs in order to understand more about the particular features of the replication of these viruses, the synthesis and the mechanisms of the polyhedrin crystallization as well as about the relationships between the insect cell and the CPV's will be presented and discussed in this paper.

In particular, the relations between the CPV strain and the nature of the host cell, the mechanisms of the viral propagation, the persistence of the viruses in tissue culture and the suseeptibility of an insect cell line to different viruses or CPVs were investigated. Some relationships between the CPV strain and the insect cell important for a complete normal replication of the virus and the crystallization of the polyhedrin were identified. Studies on the influence of the temperature on the viral replication demonstrated the viral replication at lower temperatures as 4°C without however any synthesis of polyhedrin. Suitable cell lines permitted also the identification and the separation of CPV strains from an infected insect as well the demonstration of the persistence of a CPV infection and the transmission and the propagation of the CPV infection from one cell to another.

APPROACHES FOR OBTAINING RECOMBINANT CYTOPLASMIC POLYHEDROSIS VIRUSES. Jun Kobayashi, Hajime Inoue (National Institute of Sericultural and Entomologieal Science, Ibaraki, Japan), Serge Belloncik (Institute Armand-Frappier, University du Québec, Laval. Canada).

Cytoplasmic polyhedrosis viruses (CPV), members of Reoviridae, infect midgut cells of a wide range of insects. The infection is characterized by the production of large intracytoplasmic inclusion bodies which are formed by the crystallization of the viral polyhedrin polypeptide around infectious viral particles. These polyhedra are believed to play an important role in stabilizing occluded virions in the environment and to be non-essential for viral replication.

Therefore, like baculoviruses, recombinant CPV are expected to become not only valuable expression vectors but also effective insecticides. In addition, the CPV infection is characterized.by its persistence in the insect larvae and cell lines as well as by its non cytolytic infection pathway which give two major advantages of using the CPV's rather than the baculoviruses as expression vectors

There are no established techniques for obtaining recombinant and/or reassortant CPV. However, coinfection of different CPV s or cotransfection of viral RNA in permissive cell lines are currently investigated for the inducement of reassortants and recombinant viruses. In this presentation, we point out problems related to the development of recombinant (reassortant) CPV, and results obtained in our laboratories for resolving these problems will be presented and discussed.

CONCLUSION; PROSPECTS. Hajime Mori (kyoto Institute of Technology, Kyoto, Japan) and Serge Belloncik (Institut Armand-Frappier, Université du Québec, Laval, Canada).

Several new research datas on insect cytoplasmic polyhedrosis viruses presented and discussed during this symposium demonstrate the importance of these viruses.

New information on the pathogenesis, the replication *in vitro* , the molecular biology and the genetic of CPVs will be integrated toward the conception of modern pest control and viral genetic engineering approaches. It is also expected and desirable that the role of these viruses in biological pest control will be reassessed in the near future and that the use of the cytoplasmic polyhedrosis viruses as non cytolytic expression vectors of genes will be more investigated.

IMPACT OF *BEAUVERIA BASSIANA* INFECTION ON FECUNDITY OF THE MASSON'S PINE CATERPILLAR. Zengzhi Li (Department of Forestry, Agricultural College of Anhui, Hefei 230036, China)

The 4th instars of the caterpillar were treated with high (1x10 conidia/ml) and low(4x10) concentrations of conidial suspension of Beauveria. The surviving larvae were reared and allowed to pupate for further development observation. Mortalities on the 15th day, pupation rates, emergence rates of the pupae as well as pupal weights were tested. The results all showed an obvious tendency of reduction as the treatment concentration was increased.The male and female pupae were paired and allowed to emerge depositting observation. The result showed reduction of oogenesis as the concentration got increased. Number of fertilized eggs of the treatments and the control were estimated after the whole experiment was completed. They were 1283, 4826, and 9604 for the high and low concentration and the control, respectively. The actual increase rate of the experimental population were determined to be 12.83,48.26,and 96.04. Consequently, the reduction of the increase rate of the caterpillar population by the high concentration treatment was estmated as (96.04-12.83)/96.04x100%=86.6% and that by low concentration 49.8%.

The results indicate that the infection by Beauveria bassiana exerts important influence on both individual development and population dynamics of the caterpillar

SUSCEPTIBILITY OF THE CITRUS RUST MITE, *PHYLLOCOPTRUTA OLEIIVORA* (ASHMEAD), TO DIFFERENT STRAINS OF *HIRSUTELLA THOMPSONII* FIRHER, Chandrapatya, A. (Department of Entomology, Kasetsart University, Bangkok 10900, Thailand), C.W. McCoy (Citrus Research and Education Center, 700 Experiment Station Rd, Lake Alfred, Fl. 33850, U.S.A.).

Seventeen isolated of *Hirsutella thompsonii* representing three distinct varieties, *thompsonii, synnematosa* and *vinacea* were bioassayed against adult citrus rust mite, *Phyllocoptruta oleiivora* (Ashmead). A fungal conidial suspension at a concentration of 10^5/ml was prepared and a 5 ul drop was applied directly onto each mite. After 2 days incubation at 25°C, the number of infected mites were identified microscopically.

Fungal isolates SSi-72, 3W, 13, 5 and 20 were most pathogenic with infection ranging from 49-71%. Isolate SSi-72 is a mutant selected in the laboratory for multiple conidia per conidiophore.

THE RECENT DEVELOPMENT ON THE STUDY OF *BEAUVERIA* IN CHINA. Ai-wen Zhang, Chun-sheng Deng, Xiang-qiun Nong (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing, 100081, China)

In recent years, the method of industrial production of *Beauveria bassiana* has broken through the traditional two-phase method and gotten an improved two-phase system. With this new process, the culture of abundant mycelium is carried out in the dense liquid medium that the content of dried subtracts are about 14%, and the sporulation is completed on a kind of cheaper unsterilised carrier. The yield of conidia is near $1.5X10^{11}$ per gram after the spore collection, and the whole process is only need 9 to 11 days. There are several preparation styles of *Beauveria bassiana* appeared, among them, the highly concentrated powder, and the wettable powder are more convenient. The security of *Beauverria* to human and animals has been confirmed. About the application of *Beauveria* to control pests in a large-scale of farm and forest, the most successful examples are as following: pine caterpillar (*Dendrolimus sp.*), asian corn borer (*Ostrinia furnacalis*). The better result of peach fruit moth (*Carposina nipponensis*), grub (*Scarabaeoidea*) have been obtained. There are nearly 600,000 ha of farm and forest that pests have been greatly controlled in China.

MODE OF ACTION OF CHEMICAL ADDITIVES IN ENHANCING THE POTENCY OF BACILLUS THURINGIENSIS AGAINST LEPIDOPTEROUS INSECTS.
H.S. Salama, M. Abdel-Baset, M. Ragaei (National Research Centre, Dokki, Cairo, Egypt).

Sonnication of a suspension of Bacillus thuringiensis var. kurstaki HD-1 followed by combining it with non-toxic chemical additives or exposure to dynamic magnetic field and its enhancing effect on the potency against the cotton leafworm, Spodoptera littoralis has been investigated. Sonnication coupled with or without chemical additives led to an increase in the endotoxin protein solubility, as well as suphahydryl content, enthalpy and entropy. The existance of the endotoxin protein in the form of trimer, dimer and monomer was demonstrated by chromatography. The cleavage of dimer and monomer from the trimer protein occurred more obviously, when guanidine sulphate was added after sonnication. A similar mode of action occurred when sonnication of B. thuringiensis was followed by exposure to dynamic magnetic field.

STATUS OF BACILLUS THURINGIENSIS RESISTANCE IN DIAMONDBACK MOTH IN THE CONTINENTAL UNITED STATES.
A. M. Shelton (Department of Entomology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456 USA).

In 1990 nine populations of diamondback moth, Plutella xylostella L., were collected from Brassica plants in six states of the United States and tested in laboratory assays against commercial formulations of Bacillus thuringiensis subsp. kurstaki. Results indicated that some populations were very susceptible while others had high levels of resistance (>200-fold). This variation in susceptibility could be explained by the frequency of past use of B. thuringiensis products. The highest levels of resistance occurred in populations which originated from Florida, an area in which diamondback moth pressure is intense.

In 1992 field trials with B. thuringiensis subspp. kurstaki and aizawai were conducted in the main cabbage-growing areas of Florida. Variation in susceptibility in populations was again documented and traceable to past use patterns, but there was no cross-resistance between the subspp. of B. thuringiensis.

These data provide evidence that high levels of resistance and control failures may occur in fields after extensive use of available B. thuringiensis products. Although the present lack of cross-resistance between subspp. may provide some flexibility for managing B. thuringiensis resistance, limiting selection pressure to any of the B. thuringiensis toxins will be necessary if B. thuringiensis is to remain a durable insecticide complex.

Interaction Of Temperature And Moisture On The Survival and Pathogenicity of entomogenous nematode, *Steinernema carpocapsae* To Wax Moth Larvae. Wen-Feng.Hsiao (Dept. Applied Microbiology & Food Science, Univ. Saskatchewan, Saskatoon, Sk., Canada, S7N 0W0) and John N. All (Dept. Entomology, Univ. Georgia, Athens, GA., 30602, U.S.A.)

Effect of abiotic factors on survival and pathogenicity of the infective juveniles stage (IJ_3) of *Steinernema carpocapsae* (Weiser) to wax moth larvae were investigated under laboratory condition.

Four different soils from Georgia were used in this study: sand, cecil coarse sandy loam, sandy clay loam and silty loam. *S. carpocapsae* were inoculated into each of the four soil types and were placed at -20, 5, 25, and 35°C. with various moisture 5, 20, 35, 50 and 65% in gravimetric wetness and field capacity.

The survival rate of *S. carpocapsae* were determined from the number of nematodes recovered from Baermann funnel extractions of the soil. The pathogenicity was determined by the mortality of *Galleria* larvae infected by nematodes extracted from each treatment.

Survival of nematodes was lower in saturated soil than unsaturated soil (maintained at field capacity) in all four soil types at 5°and 25°C. Irrespective of the various moisture levels, very few surviving nematodes were found at -20° and at 35°C. The highest number of nematodes were found at 5°C from unsaturated soil, as compared with the other temperature.

IS PHASE VARIATION IN *XENORHABDUS NEMATOPHILUS* MEDIATED BY GENOMIC REARRANGEMENT? Adam J. Smigielski and Raymond J. Akhurst (CSIRO Division of Entomology, Canberra, ACT, 2601, AUSTRALIA).

Phase variation is common to *Xenorhabdus* spp., bacteria symbiotically associated with entomopathogenic nematodes from the families Steinernematidae and Heterorhabditidae. The change from phase one, which is carried by wild-type infective juvenile nematodes, can result in reduced nematode reproduction because the nematodes are dependent on nutrients produced by specific bacterial metabolic pathways not active in phase two. No advantage to either the nematodes or to *Xenorhabdus* has been shown to follow from the phase one to two conversion. However, since phase variation occurs in all *Xenorhabdus* spp. associated with nematodes, it is obviously a significant element of the symbiosis. In an attempt to determine its significance, we are investigating the molecular basis of phase variation in these bacteria.

Since phase variation in other members of the family Enterobacteriaceae can occur via genome rearrangements mediated by an invertase enzyme, *Xenorhabdus* spp. were examined for a similar mechanism. All *Xenorhabdus* spp. examined were shown to have a DNA sequence homologous to the *Salmonella typhimurium* invertase gene. An homologous gene was subsequently isolated from a *Xenorhabdus nematophilus* genome libary using Southern biot hybridization. This gene was sequenced, inactivated by insertion of an Omega fragment, and used to replace the wild-type gene in *X. nematophilus*. The impact on phase variation was subsequently evaluated in conjunction with Southern Cross hybridization experiments which is used to investigate genome rearrangements.

ENTOMOPATHOGENIC NEMATODE PRODUCTS: THE DECISION MAKING PROCESS. Ramon Georgis, Kirk A. Smith (Biosys, 1057 East Meadow Circle, Palo Alto, Ca 94303, USA).

Entomopathogenic Nematode products based on the genera Steinernema and Heterorhabditis have emerged as excellent candidates for biological control of soil insect pests. Progress achieved in liquid fermentation (up to 80,000 liter), formulation stability (e.g. Clay, gels) and application strategy has allowed nematode-based products to become competitive with chemical insecticides in medium and high value crops (in the United States, Canada and Western Europe) on the basis of cost/benefit ratio and ease of application.

In the past few years chemicals available to the farmers for soil application have become more restricted. Farmers must go through a logical "Decision Making Process" to decide if these nematodes are feasible alternatives to chemical pesticides. Involved in this "Decision Making Process" are a number of important factors which can be categorized as follows:

1. Geographical considerations: soil type and weather
2. Agronomic considerations: timing and method of application
3. Pest considerations: stage and pest population
4. Crop considerations: injury level
5. Nematode considerations: persistence and compatibility with pesticides
6. Efficacy predictions: product reliability and consistency
7. Financial considerations: cost
8. Safety: environment and workers

HELEIDOMERMIS MAGNAPAPULA (NEMATODA: MERMITHIDAE) AS A POTENTIAL BIOLOGICAL CONTROL AGENT OF CULICOIDES VARIIPENNIS (DIPTERA: CERATAPOGONIDAE). E. O. PAINE AND B. A. MULLENS (DEPARTMENT OF ENTOMOLOGY, UNIVERSITY OF CALIFORNIA, RIVERSIDE, CA 92521)

Culicoides variipennis is a known vector of bluetongue virus. The only known host-specific natural enemy is the mermithid nematode, Heleidormermis magnapapula. A survey throughout California indicated the nematode has statewide, but sporadic distribution. Intense surveys of a permanent pond indicated distinct seasonal fluctuations in parasitism and showed nematode occurrence in the adult fly is very rare (<.06%). Nematodes were held at 5 temperatures to determine developmental thresholds. The nematode has been reared through one generation in the laboratory to date. This allows for more detailed studies on host-parasite relationships.

MYCOPARASITES OF BROWN PLANTHOPPER (BPH) AND OTHER RICE PESTS IN INDIA. Narayanasamy P, L. Udaya Prabhakar (Mycoinsecticide Scheme, Department of Entomology, Annamalai University, Annamalainagar - 608 002, India).

In a continued intensive survey and collection of fungal diseases of major pests of rice including BPH from Tamilnadu and Karnataka of India, about 25 fungal pathogens were detected. Of these 17 were isolated from their respective cadavers and identified to be infecting pests like Nilaparvata lugens, Nephotettix virescens, Mythimna separata, Cnaphalocrocis medinalis, Scirpophaga incertulas, Nymphula depunctalis, Recilia dorsalis, Scotinophora lurida and Echinocnemus oryzae. Among the fungi, Pandora delphacis, Mucor hiemalis and Rhizopus oryzae were predominant on BPH causing mortalities of 57.9%, 42.9% and 40.70%, respectively.

P. delphacis was found spectacularly infective against all instars of BPH and thus proved to be a potential mycoparasite. The pathogens that are recorded for the first time in India are: Mucor hiemalis, Pandora delphacis, Rhizopus oryzae, Zoophthora radicans, Metarrhizium album, Nomuraea rileyi, Cladosporium sp. and Entomophthora aulicae.

IMPACT OF *BEAUVERIA BASSIANA* ON NUTRITIONAL PHYSIOLOGY OF THE MASSON'S PINE CATERPILLAR. Zengzhi Li (Department of Forestry, Agricultural College of Anhui, Hefei 230036 China)

The 4th instars of the caterpillar were treated with high($1x10^7$ conidia/ml) and low($4x10^6$) concentrations of conidial suspension of Beauveria, reared routinely, and weights of pine needles consumed, feces, as well as each larva were recorded daily. The result showed that during the period from the treatment to the 15th day when death due to the infection began, the needle consumption (Y) of each larva was correlated to the day(x) after treatment in the following forms: For high concentrtion treatment: $Y_2=41.55-25.52x_2+4.44x_2^2$; fow low concentration treatment: $Y_1=41.82-24.86x_1+5.41x_1^2$; for control: $Y_0=84.53-36.69x_0+6.85x_0^2$. Based on the above models, loss of pine needles by the caterpillar was decreased due to Beauveria infection durinr the period by 44.4% for high concentration and 19.6% for low concentration. There were no significant difference between AD's. ECI's and ECD's were significantly lower than that of the control, and once showed negative values, indicating that the infection did not affact digestibility of the insect, all food was not used fully, and a portion of it was converted into energy for severe defence reaction, and even some substance inside the host bodies was used for the conversion, and also indicating that the fungus had invaded into the hosts and started absorbing the nutrients of the larvae for multiplication.

ON THE PERSISTENCE OF GREEN MUSCARDINE FUNGUS EXTRACTANT IN SOIL AND ITS USE AGAINST PEACH FRUIT BORER. Mei-zhen Fan, Chao Guo, Nong-chang Li (Department of Forest Protection, Northwest College of Forestry, Yangling Town, Shaanxi Province 712100, China).

Sugar solution of 3.5-4 molarity was used to extract the conidia and mycelium fragments fo Metarrhizium anisopliae (Metschn.). The extractants were inoculated into soil at different times to determine the variation of pathogenicity on peach fruit borer Carposina nipponensis Walsingham, and a selective medium was adopted to test CFU. The results indicated that the viability of the inocula to this insect reduced with time, and the reduction rate in soil was slower than that in room condition. The CFU value after 383 days remained at about 20/g inoculum. All the eight treatments showed high pathogenicity, even 165 days after inoculation, with mortality ranged from 96.7-100%. A conidia priparation of 5×10^9/g concentration was used to treat the orchard soil during the emergence peak of this insect, the mean bored apple rete of samples from 25 treated orchards was only 2.35%, significantly lower than that from control orchards. The CFU values one year later in treated orchards remained at 2.0-6.9 g soil.

THE MASS REPRODUCTION AND COMMERCIAL APPLICATION OF MICROSPORIDIA AGAINST GRASSLAND LOCUST. Li-ying Wang (Department of Plant Protection, Beijing Agricultural University, Beijing 100094, China). Xiao-guang Yu, Chang-xu Yang, Abuduwaili (Xinjiang Command Post of Grasshoppers and Rodents Control, Xinjiang Wuiwer Autonomous Region, China)

As the oriental migratory locust Locusta migratoria manilensis (Meyen) infected by microsporidia Nosema sp., there were two developmental stages of this microsporidia, schizogomy and sporogony, detected in dead body of the host, under phase contrast microscope. The former stage mainly occurred in the body died earlier, and had few spores produced; while in the body died much later, it was in the latter stage and produced much more spores. The death time of this locust was related to the inoculated dosage and age of host, which are the key factors of mass reproduction of this microsporidia.

In an aerial spraying experiment, $1.5\text{-}2.2\text{X}10^{10}$spores/1500g of wheat bran/ha. were used, the infectivity and population decrease rate four weeks after spraying were ranged from 19-44% and 36-60% respectively.

Verticillium lecanii **Protease Is Not Involved In The Virulence To the Oat-bird Cherry Aphid, *Rhopalosiphum padi*.** Wen-Feng Hsiao, M. J. Bidochka and G. G. Khachatourians (Bioinsecticide Research Laboratory, Dept. Applied Microbiology & Food Science, Univ. Saskatchewan, Saskatoon, SK S7N 0W0, Canada)

In several entomopathogenic fungi, extracellular proteases are recognized to be important virulence factors. We are interested in the role of extracellular catebolic enzymes of entomopathogenic fungus, *Verticillium lecanii* (Vl) infection of various aphid species including *Rhopalosiphum padi* (Rp). The relationship between extracellular protease production by Vl and virulence toward Rp was investigated by generating several protease deficient (pro-) Vl mutants. Alatae and apterous aphids were bioassayed. Differences in virulence of Vl mutant strains toward Rp were observed but no clear relationships with virulence and protease production were apparent. We conclude that differences in Vl strains with respect to protease production does not relate to differences in virulence.

A POSSIBLE NEW SPECIES OF MICROSPORIDIAN FROM THE MOSQUITO, Culex fuscanus (DIPTERA: CULICIDAE). Wei-June Chen and Su-Chuan Wu (Department of Parasitology, Kaohsiung Medical College, Kaohsiung 80708, Taiwan, China)

In a routine mosquito survey, fifteen 4th instar larvae and 1 pupa of the mosquito, Culex fuscanus, infected with microsporidian parasite were collected in a large metal container from Liu-Chiu islet in southern Taiwan. The shape of the spore was oval. The size was 7.38 ± 0.63 um in length and 4.59 ± 0.47 in width. Pansporoblast contains 8 mature spores. Infected mosquito larvae tend to move slowly and became porceilain white and swollen throughout the body. After dissection, whole body was full of spores. Thus far, only the sporogonic sequence producing octospores is known in this species. According to our observation, the larvae with patent infection usually die before they emerged. Microsporidian infection has not ever been described in Culex fuscanus. Therefore, this new infection might be due to a new species of microsporidian. The ultrastructrural study of the microsporidian is now ongoing.

The Relationship Between The Relative Humidity And Growth Temperatures For Populations Of The Bird-Cherry Oat Aphid , *Rhopalosiphum padi* And Infected By *Verticillium lccanii*. Wen-Feng Hsiao, M. J. Bidochka and G. G. Khachatourians (Bioinsecticide Research Laboratory, Dept. Applied Microbiology & Food Science, Univ. Saskatchewan, Saskatoon, S7N 0W0, Canada)

Temperature and moisture are known to affect infection of insects by pathogenic fungi. These environmental factors were tested in the aphid, *Rhopalosiphum. padi*, infected by*Verticillium lccanii*. in laboratory. The temperature has an effect on mortality and fecundity on infected and non-infect-ed aphids. Mortality of infected apterous adults was100% on day 3 at 22 and 27°C, and day 4 at 16°C. Significantly lower fecundity was observed in in-fected aphids. No reproduction was shown at 8°C for 14 d and all aphids died at 37°C whether they were infected or not. There was a positive relationship between temperature (up to 27°C) and mortality due to *V. lecanii*. Fecundity of control aphids was 17.8, 42.0 and 27.3 offspring per 7 d and 7.9, 9.2, and 5.8 offspring for treated aphids at 16°, 22°, and 27°C, respectively. No differences in aphid mortality due to *V. lccanii* were observed at relative humidities from 12-100%. However, aphids which had died due to *V. lecanii* and placed at high relative humidities (76-100%) showed visible fungus growth on the cadaver within 2 d.

HOST PARASITE RELATIONSHIPS OF MICROSPORIDIA INFECTING MOSQUITOES
A.W. Sweeney, Army Malaria Research Unit, Ingleburn, NSW 2174, Australia

Heterosporous microsporidia are important natural controlling factors of mosquitoes. Recent studies have shown copepods are intermediate hosts of the genera Amblyospora (Sweeney et al., 1985), Parathelohania (Avery and Undeen,1990) and Duboscqia (Sweeney et al., 1990). These parasites have two horizontal transmission sequences (from mosquitoes to copepods and from copepods back to mosquitoes) and a vertical (transovarial) transmission sequence between successive mosquito generations. The latter characteristic would appear to be a favourable attribute for biological control as it should aid parasite dispersal and persistence within infected host populations. The host parasite relationships of several microsporidia infecting important pest mosquitoes and disease vectors in Australia will be reviewed.

EFFECTS OF A MICROSPORIDIUM ON THE BIOLOGY OF *Empoasca fabae*. Xinzhi Ni, Elaine A. Backus (Department of Entomology, University of Missouri, Columbia, MO 65211, U.S.A.), Joseph V. Maddox (Illinois Natural History Survey, Urbana, IL 61820 U.S.A.)

A newly discovered microsporidium associated with the potato leafhopper, *Empoasca fabae* (Homoptera: Cicadellidae), was described. The microsporidium mainly distributed in salivary glands, alimentary canal, Malpighian tubules, and ovarioles. The effects of the microsporidium on the leafhopper biology (e.g., adult longevity, feeding behavior, and fecundity), and the possible transmission mechanisms of this microsporidium in the leafhopper population would also be discussed.

RELATIVE PATHOGENICITY OF TWO PLAQUE VARIANTS OF PERINA NUDA NUCLEAR POLYHEDROSIS VIRUS. Chung-hsiung Wang, Yuung-chiarng Wang, Pai-San Tsai (Graduate School of Biology, Fu-Jen University, Taipei, 24205, Taiwan China) and Chu-Fang Lo (Zoology Department, National Taiwan University, Taipei, Taiwan, China)

Perina nuda nuclear polyhedrosis virus (Pn NPV) had been successfully replicated in newly established cell line, PN-HH. Two relative virus strains,Θ (multiple polyhedra, MP strain) and G (few polyhedra, FP strain) were isolated by plaque assay method.

Comparison of the pathogenicity of these representative phenotypic strains in vivo showed that G strain was more virulent against larvae of *P. nuda* than Θ strain by inoculation of ECV (extracellular virus) whereas the results from the mixed inoculum of two strains implied strongly that interference in pathogenicity was found. In contrast ,the results from in vitro studies had shown that there was no significant difference in TCID50/ml titration, thus Θ strain produced more abundant PIB than did G strain. Restriction endonuclease analysis of both DANs confirmed that several different migration patterns were observed.

A REOVIRUS IN A HEALTHY COLONY OF THE BROWN PLANTHOPPER, NILAPARVATA LUGENS. H. Noda, N. Nakashima (National Institute of Sericultural and Entomological Science, Tsukuba 305, Japan), K. Ishikawa, H. Hibino, T. Omura (National Agriculture Research Center, Tsukuba 305, Japan)

A reovirus was found in an apparently healthy colony of the brown planthopper, Nilaparvata lugens. The virus was purified and characterized in order to compare with planthopper-borne plant viruses and to study the interaction between commensalistic microorganisms and host insect.

This virus had double-shelled particles approximately 65 nm in diameter, containing 10 genome segments of dsRNA. The virus was sometimes associated with tubular structures, which is one of the characteristic features in tissues infected with reoviruses. The electrophoretic profile of the dsRNA segments differed from those of reoviruses associated with rice planthoppers and leafhoppers. The virus was, therefore, referred to as the Nilaparvata lugens reovirus (NLRV). A virus antigen was detected in individual insects by ELISA. Using virus-infected and virus-free planthoppers, virus transmission was investigated. The virus was vertically transmitted through female and was also transmitted horizontally. The nucleotide sequences of cloned cDNA of genome segments suggest that NLRV is closely related to Fijivirus-subgroup II in plant reoviruses.

THE ANALYSIS OF A UNIQUE PERSISTENCY-ASSOCIATED HZ-1 VIRAL TRANSCRIPT. Yu-Chan Chao, Cherng-Yu Chang, Chi-Wu Chen and Song-Tai Lee (Institute of Molecular Biology, Academia Sinica, Taipei, Taiwan, China)

Hz-1 viral RNA transcription was studied during productive and persistent infections. Under conditions of persistent infection, we detected only one viral persistency-associated transcript (PAT1). PAT1 was also proved to be an immediate early gene product during viral productive infection. The region of the viral DNA which encodes PAT1 has been cloned and sequenced. No significant open reading frame was found in the RNA encoding region of PAG1. Computer searches showed that the sequence contains multiple copies of inverted and direct repeats. RNA folding analysis showed that the secondary structure of PAT1 is very complicated which is mainly double stranded. PAT1 is about as abundant as actin mRNA in some of the persistently infected cell lines, however, no related protein was detected from the PAT1 expressing cell lines.

EXPRESSION OF CYTOPLASMIC POLYHEDROSIS VIRUS POLYHEDRIN USING BACULOVIRUS EXPRESSION VECTOR. Hajime Mori, Hiroshi Nakazawa, Motoyuki Sumida, Fujiyoshi Matsubara (Kyoto Institute of Technology, Kyoto, Japan), Ken-ichi Higo and Yuzo Minobe (National Institute of Agrobiological Resources, Tsukuba, Japan)

A wild type (strain H) of *Bombyx mori* cytoplasmic polyhedrosis virus (*Bm*CPV) and a mutant (strain A) produce polyhedra in cytoplasm and nucleus respectively. We have determined nucleotide sequences of polyhedrin genes of both strains and reported two sites of mutations in amino acid sequences. To identify a nuclear localization signal (NLS) of strain A, polyhedrin genes of these two strains were expressed using a baculovirus expression system. After *Bm*CPV polyhedrin gene was cloned into a transfer vector pAcYM1, *Ac*NPV DNA was cotransfected with the transfer vector into *Spodoptera frugiperda* cells. Recombinant viruses containing *Bm*CPV polyhedra were isolated by plaque assay and intracellular localization of *Bm*CPV polyhedrin was investigated by Western blot analysis. Strain A polyhedrin more exclusively localized in nucleus and strain H polyhedrin localized in cytoplasm and nucleus. When ricombinant genes which contained one mutation were constructed and expressed, it was suggested that a mutation at the C-terminal end of strain A polyhedrin related to the nuclear localization. Chimera genes carrying the N-terminal sequence of firefly luciferase fused in-frame to C-terminal sequence of BmCPV polyhedrin were expressed. By determining the cellular location of the light emission, we showed that the C-terminal end of strain A polyhedrin was NLS.

CONTROL OF CUTWORMS USING BACULOVIRUSES

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Cutworms (*Agrotis* spp.) are polyphagous insects with a worldwide distribution which can be pests on a wide range of crops from vegetables to forest nurseries. They spend much of their time in the soil and can thus be difficult targets for chemical control measures. They also appear to have a little or no sensitivity to *Bacillus thuringiensis* subspecies *kurstaki*. Baculoviruses are arthropod specific viruses which have been used for the control of a wide range of agricultural and forest pests. Two types of baculovirus have been isolated from the larvae of *Agrotis segetum*, the common cutworm, a nuclear polyhedrosis virus (AsNPV) and a granulosis virus (AsGV). Previous control studies have concentrated on the GV. Here we have compared the NPV and the GV, using both spray and bait treatments, for the control of *A. segetum*. Small scale field trials on maize in Spain and on beetroot in the UK have demonstrated that, although high levels of mortality can be obtained with both viruses, AsNPV acts more rapidly than AsGV and thus is probably a better option for control of these pests. Interestingly, the use of a mixed inoculum (AsNPV + AsGV) appears to affect the infection process, giving a time between ingestion of the inoculum and death which is intermediate to the response of either virus alone. This suggests that the GV may be antagonistic to the NPV.

BACULOVIRUS CONTROL OF THE PINE BEAUTY MOTH, *PANOLIS FLAMMEA*: VIRUS PERSISTENCE IN THE SEASON AFTER SPRAY APPLICATION

Jenny S. Cory, Richard Giles*, Cathy J. Doyle & Philip F. Entwistle
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The pine beauty moth, *Panolis flammea*, (Lepidoptera: Noctuidae) is a major pest of lodgepole pine (*Pinus contorta*) in the UK. A nuclear polyhedrosis virus (NPV) has been isolated from *P. flammea* and has been shown to be effective as a control agent. NPVs are occluded in a proteinaceous matrix which gives them a degree of environmental persistence. Part of the studies on the ecology of the *P.flammea* /PfNPV interaction have involved investigation of virus persistence in lodgepole pine forests in Scotland. Monitoring sprayed plots the year after application has demonstrated a low level of persistent virus in the host population. Infection in the year n + 1 could be related to the number of virus inclusion bodies produced in year n. Preliminary attempts have been made to model this process. These indicate that the majority of PfNPV is rapidly lost from the tree. However, other studies in which environmental and host mediated components of persistence have been separated, indicate that persistence of PfNPV on the foliage appears to be the main route for the maintenance of virus in the population.

SELECTION OF BACULOVIRUSES FOR THE CONTROL OF AGRICULTURAL PESTS IN NICARAGUA

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Several nuclear polyhedrosis viruses (NPVs) have been isolated from lepidopterous pests of field crops in Nicaragua. As part of their assessment as potential bioinsecticides these have been biochemically and biologically characterized and compared with other published isolates. Restriction endonuclease digestion and DNA hybridization studies using dot blots have revealed two new isolates; an NPV of *Spodoptera albula*, the black armyworm (sometimes called *S. sunia*) and a variant of *S. frugiperda* NPV not previously described. LD_{50} values have been estimated for the virus isolates in Nicaraguan insect stocks, some of which show a resistance to the native NPV which disappears on in-breeding. Cross infection assays (which have included the wide host range *Autographa californica* NPV) have demonstrated little true cross-infection between the isolates and insects from the pest complex, thus control of a mix of species with a single isolate appears unlikely. Viruses failed to adapt to new host species and latent viruses appear to be present in several of the insect populations. This makes the production of several isolates in a single host unlikely. The relevance of these results to field control will be discussed.

BIOLOGY AND TOXICITY OF BACILLUS THURINGIENSIS FROM SOILS IN CHINA. Rong-sen Li, Shun-ying Dai, Xiao-gang Li, Ying-chun Zhao and Chun-e Sun (Wuhan Institute of Virology, Academia Sinica, Wuhan 430071, Hubei, China)

130 isolates of Bacillus thuringiensis were isolated from soils in southwest, northwest, south and center of China. These isolates were belonged in 17 serotypes (H0, H3-8, H10, H13, H20-22, H24, H26-29) out of 29 serotypes of Bacillus thuringiensis. 9 species of insects in Lepidoptera, Coleoptera and Diptera were used for assay of δ-endotoxins. The morphology of cells, spores and parasporal crystals of all isolates was investigated under transmission and scanning electro-microscope. Proteins of δ-endotoxins from all isolates were analysed by rapid SDS-PAGE.

Most of bipyramid crystals with proteins of 130-140kD and bifrustrum-pyramid crystals with proteins of 50kD showed no toxicity or very low toxicity in larvae of Lepidoptera, Coleoptera and Diptera. All sorts of mosaic-bipyramid with both of 130-140 kD and 65-68kD proteins possesed very high toxicity to larvae of Lepidoptera including Noctuidae. Some crystals with forms of cube, polyhedron, globe or cup-like were effective to larvae of Coleoptera (Chrysomelidae, Bruchidae, etc.) and contained proteins of 35-74kD or proteins of 130-140kD and 34-68kD. Multi-shape crystals were very active to Prodenia litura and they were consisted of 130-138kD proteins.

PRODUCTIVE AND PERSISTENT INFECTIONS OF HELIOTHIS ARMIGERA SINGLY EMBEDDED NUCLEAR POLYHEDROSIS VIRUS IN ITS HOMOLOGOUS CELL LINE, SFE-HA-8212. Jiang Zhong, Yun-xian Yue, De-ming Su (Fudan University, Shanghai 200433, China)

Two forms of in vitro were found in the cotton bollworm baculovirus, Heliothis armigera nuclear polyhedrosis virus, singly embedded (HaSNPV), grown in a homologous cell line SFE-HA-8212: one productive and the other persistent. In productive infection, the virus replicates efficiently in cells, producing cytopathologic effects(CPEs) characteristic of baculovirus infections.37.8±7.6% of the total cell population infected by the virus produced polyhedra, while 89.6±21.4% of cells (including those produced polyhedra) were capable of releasing free virions into culture medium. Under optimum conditions each cell produced an average of 14.4 pfu virus particles and 25.8 polyhedra. Cells survived from productive infections were then carefully selected and a total of 13 persistent cell lines were established and characterized. All these cell lines were capable of releasing virus particles for various long terms, the longest up to two years. Differences in cell morphology, growth and virus releasing patterns were found among cell lines, indicating diversity and complexity of cell-virus interactions in vitro. The mechanism of baculovirus persistent infections is discussed.

SYNERGISTIC EFFECTS OF THURINGIENSIN AND THE SPORA-CRYSTAL AGENTS OF BACILLUS THURINGIENSIS ON THE LARVAE OF PLUTELLA XYLOSTELLA, HELIOTHIS ARMIGERA (LEPIDOPTERA) AND EPILACHNA NIPONICA (COLEOPTERA). Kai-chun Lin, Zi-niu Yu (Department of Soils and Agrochemistry, Huazhong Agricultural University, Wuhan 430070, China)

Thuringiensin (T) and the spora-crystal agents (SC.) of B. thuringiensis strain HD-1, WP-1 (subsp. kurstaki), 81-6 (subsp. galleria) and CT-43 (subsp. chinensis) were separately mixed for the determination of synergistic effects in the laboratory. The synergistic activities were shown by Co-toxicity coefficient (CTC). Synergism took place in the all tests on the two kinds Lepidopterous insects, the CTC tested with P. xylostella and H. armigera were 127-638, and 120-209. The results tested with the spora-crystal of CT-43 and thuringiensin against E. niponica larvae showed obvious synergistic effects, but the results of HD-1 were only additive. In the tests, the CTC values changed in response to different infection temperatures or times, or in the different growth stages of larvae. When the SC. were used as the principal portion of the mixture, the best proportion was SC.:T=100:20 (w/w); while if the thuringiensin was the main component, the best ratio was SC.:T= 10-25:100 (w/w).

SYNTHESIS AND TOXICITY OF FULL LENGTH AND TRUNCATED BACTERIAL CryIVD MOSQUITOCIDAL PROTEINS EXPRESSED IN LEPIDOPTERAN CELLS USING A BACULOVIRUS VECTOR

Yi Pang, Roger Frutos and Brian A. Federici
Department of Entomology, University of California, Riverside, California 92521 U.S.A.

Full length (72K) and truncated (61K) CryIVD mosquitocidal proteins of *Bacillus thuringiensis* (Bt) were expressed in *Spodoptera frugiperda* cells and larvae of *Trichoplusia ni* using a baculovirus vector to investigate the role of CryIVD peptides in toxicity as well as to further evaluate the baculovirus/lepidopteran system for expressing Bt proteins. Infected cells and purified inclusions from the recombinant virus (AcCryIVD) expressing the full length protein were highly toxic to mosquito larvae, but similar preparations from the virus (AcCryIVD-C) expressing the truncated protein with a 9.6K deletion at the N-terminus were non-toxic. Proteolysis with trypsin of CryIVD proteins produced by Bt and the recombinant AcMNPVs yielded peptides corresponding in size, showing that synthesis of mosquitocidal Bt proteins in lepidopteran cells was competent. The lack of toxicity of the truncated CryIVD protein, which like the toxic full length protein yielded a 34K protein on proteolysis that has been implicated in toxicity, indicates that by itself this protein is non-toxic. These results demonstrate the utility of the baculovirus system for expression of mosquitocidal Bt proteins and for investigation of their mode of action.

INSECTICIDAL CRYSTAL PROTEINS AND TOXICITY OF BACILLUS THURINGIENSIS SUBSP. CHINENSIS CT-43. Zi-niu Yu, Ming Sun, Jian-bin Zhang, and Guang-dong Ou (Department of Soils and Agrochemistry, Huazhong Agricultural University, Wuhan, 430070, China)

Bacillus thuringiensis subsp. chinensis CT-43(nonflagellum) showed high toxicity against a wide range of insects, and produced very large and variedly shaped crystalline inclusions, which contained 140-kDa, 130-kDa and 63-kDa insecticidal crystal proteins (ICPs) as determined by SDS-PAGE. Two types of mutants were selected by curing experiments. Type I only produced bipyramidal crystals consisting of 140-kDa ICP, whereas type II produced bipyramidal and cuboidal crystals consisting of 130-kDa and 63-kDa ICP, respectively. Based on the SDS-PAGE profiles of soluble 130-140 kDa, 140-kDa and 130-kDa ICPs activated by trypsin and midgut extract, the 140-kDa and 130-kDa ICPs would probably be CryIB and CryIA, respectively, according to the system of Hofte etal(1988, Appl. Environ. Microbiol. 54:2010-2017; and 1989, Microbiol. Rev. 53:242-255). They were quite different in immunological properties. Bioassays to Plutella xylostella were done with the soluble 130-140 kDa, 140-kDa and 130-kDa ICPs, their activated products and the purified crystals. The δ-endotoxins of this strain also exhibited toxicity to the dipteran larvae Culex fatigume and Musca domestica. The LC50 of the purified crystals to C. fatigume was 3.14 μg/ml and that of to M. domestica was in range of 10-20 μg/ml. Bioassays with crystal-spore mixtures of these mutants demonstrated that the 63-kDa ICP is the mosquitocidal factor and that the 140-kDa ICP is toxic to M. domestica larvae.

THE ATTACHMENT OF PATHOGENIC BACTERIA TO THE EPICUTICLE OF THE LARVAL SCARAB FOREGUT. Keith Binnington (CSIRO, Division of Entomology, GPO Box 1700, Canberra, Australia 2601)

Large numbers of a wide variety of bacteria are ingested by soil dwelling insects but generally do not harm the insects. One exception is the bacterium *Serratia entomophila* which attaches to the foregut epicuticle of larvae of *Costelytra zealandica*, an important scarab pest of pastures in New Zealand. The bacteria, after first colonising the foregut, cause the larvae to stop feeding before eventually invading the haemocoel and killing them. To provide an improved assay for pathogenic *Serratia* in Australia and the possibility of genetically manipulating strains of *Serratia* the factors that determine attachment of the bacteria to epicuticle need elucidating. An important factor appears to be the interaction between the bacterial fimbriae (fine hair-like appendages) and epicuticle. The types of fimbriae on *S. entomophila* are described ultrastructurally and procedures for their purification outlined. The eventual aims are to raise antibodies against the fimbriae, to use these antibodies to clone fimbrial proteins from a genomic library and then to design DNA probes for screening of soil bacteria.

To understand what type of substrate ingested bacteria first contact on the surface of the foregut the ultrastructure and composition of the epicuticle needs to be considered. Thus the literature on insect epicuticle is reviewed and ultrastructural studies, including lectin binding, made of the scarab foregut epicuticle.

AN ELEMENTARY STUDY ON CYTOTOXICITY OF BACILLUS THURINGIENSIS VAR. ISRAELENSIS 187 (CHINESE STRAIN) CRYSTALS TO CULTURED MOSQUITO CELLS. Hua-zhu Hong, Xiao-feng Song, Qu-hou Chen (Institute of Entomology, Huazhong Normal University, Wuhan 430070, China)

A new strain of Bacillus thuringiensis, which was isolated from the soil of Hunan Province, has been identified as B. t. var. israelensis187(Chinese strain). The results of bioassay in vivo showed that its toxicity was higher than B. t. i. 1897. This paper reports the cytopathological changes of cultured Ae cells infected with the crystal protein of B. t. i. 187. Ae cells are cultured in TC -199-MK medium containing 10% FBS. The crystals are activated with trypsin after treatment with alkaline buffer (0.05M , Na_2CO_3-HCl, pH10.5). The cytotoxic response of the treated cells was visible as distinct swelling, vesicles formation in cytoplasm, blurring of the membranous edge, and eventually lysis. Such morphological damage was seen as early as less than 5 min after addition of the activated crystals toxin at 0.5mg/ml. Our research also showed that unactivated crystals of 187 were toxic to cultured Ae cells, but apparently weaker than the activated crystals. Meanwhile it is interesting that activated crystals stored at -20℃ for 150 days still keep high toxic to Ae cultured cells. In vitro bioassay with Ae cells showed that LC_{50} of the fresh crystals was about 5.73×10^{5} times lower than that of the crystals prepared four years ago.

ISOLATION OF MOSQUITO-TOXIC BACTERIA FROM MOSQUITO-BREEDING SITES IN KENYA. E.J. Asimeng (Medical Vectors Programme, International Centre of Insect Physiology and Ecology, P.O. Box 30772, Nairobi, Kenya)

A large number of source materials were collected for isolating entomopathogenic bacteria from larval mosquito habitats in Kirinyaga District, Kenya. Mosquito-toxic bacteria were included among the numerous types of microorganisms isolated from the habitats. The pathogenic isolates shared common structural characteristics: they were gram-positive, spore-forming bacilli that produced parasporal inclusions conferring broad-spectrum larvicidal activity against *Anopheles, Culex* and *Aedes* mosquitoes. Based on structural and growth characteristics, coupled with larvicidal activity, the pathogenic isolates were tentatively identified as variants of *Bacillus thuringiensis*. Although the collection consisted of a variety of items including soil, silt and mud, the most productive materials were larval bodies. Using healthy mosquito larvae held in a fully permeable plastic bottle, a baiting technique was developed as a means of recovering bacteria from the environment. A simple *Bt* kit, which utilizes the local isolates and locally-available fermentation medium, is being developed for use by the rural communities.

CYTOPATHIC EFFECT OF *BACILLUS THURINGIENSIS* DELTA-ENDOTOXIN ON A CELL LINE FROM *PLUTELLA XYLOSTELLA*. Roger F. Hou, and Wei-Shing Shih (Department of Entomology, National Chung Hisng University, Taichung, Taiwan 402, China)

Cytopathic effect of delta-endotoxin from *Bacillus thuringiensis* subsp. *kurstaki* (Btk) on the cell line, PX-1187, established from the diamondback moth, *Plutella xylostella*, was observed using transmission electron microscopy. The cultured cells treated with delta-endotoxin showed ultrastructural changes. Normal PX-1187 cell has a large nucleus, several vesicles, intact mitochondria, Golgi complex and other organelles. When the cells treated with delta-endotoxin for 30 min, their granules on cristae of mitochondria became separated from inner membranes, Golgi complex having vacuoles and loose dictyosomes, and their secreted particles being shrunken. After treating for 60 min, cytoplasm was slightly vacuous, mitochondrial cristae leaking, dictyosomes showing lesion and granular cisteranes being fused. After 90 min, part of cell membranes were perforated, inner membranes of mitochondria showing lysis and parts of outer membranes being burst. In addition, fusion of granular cisteranes occurred and flocculent materials were seen in Golgi complex. After 120 min, most of cell membranes were destroyed. Outer membranes of mitochondria were largely burst. Golgi complex showed lesion on its dictyosomes and fusion of flocculent materials. The cell lysis occurred by 150 min after treating with endotoxin.

IDENTIFICATION OF A Serratia entomophila GENETIC LOCUS CAUSING CESSATION OF FEEDING TO GRASS GRUB Costelytra zealandica (Coleoptera:Scarabaeidae). Nuñez-Valdez M.E., H.K. Mahanty (PAMS, University of Canterbury, Christchurch 1, New Zealand) and T.A. Jackson (MAF Technology, P.O. Box 24, Lincoln, New Zealand).

The grass grub C. zealandica is a major insect pest in New Zealand. The larvae feeds on roots of pasture causing losses to the grass yield. The bacterium S. entomophila cause amber disease to the pest. Such disease is characterized by cessation of feeding, clearing of the gut and developing of amber coloration. We are working on the identification of the genetic loci involved in the bacterial pathogenicity. Several nonpathogenic S. entomophila strains were created by transposon mutagenesis. A S. entomophila cosmid library was screened for wild type homologous sequences to the transposon insertion site from the mutant UC24. A 5.9 Kb DNA region was isolated and cloned. Nonpathogenic S. entomophila strains carrying the 5.9 DNA fragment caused cessation of feeding to insect larvae during biotests. Analysis of those strains for expression of pathogenic determinants suggests that the 5.9 Kb DNA fragment contains a genetic locus coding for an anti-feeding toxin. This result provides the molecular basis to identify and characterize the toxin for application on the control of grass grub.

POTENCY OF SEVEN COMMERCIAL FORMULATIONS AND SCREENING OF POTENT STRAINS OF *Bacillus thuringiensis* AGAINST LARVAE OF THE AFRICAN ARMYWORM *Spodoptera exempta* (WLK). C. Bai and D. Degheele (Laboratory of Agrozoology, Faculty of Agricultural Sciences, University of Gent, Coupure Links 653, B-9000 Gent, Belgium)

The potency of seven commercial formulations of *Bacillus thuringiensis* was asssessed against larvae of the African armyworm *Spodoptera exempta* (Lepidoptera: Noctuidae). Florbac XLV is the most efficacious, followed by Delfin, HD-1, MVP, Thuricide HP, Dipel and Bactospeine XLV. Florbac XLV is about 20 times more active than Dipel and Bactospeine XLV. The LC_{50} values of Florbac XLV are 27.3, 29.4, 41.6 and 76.8 µg/ml for the first, third, fourth and sixth instar larvae 72 h after exposure. Screening of potent *B. thuringiensis* strains also has been carried out. The experiment was originally designed based on the insecticidal crystal poteins (ICPs) of *B. thuringiensis* in each tested strain. Two strains (B-1 ke and B-2 90) with a high level of activity and quick action were found. The LC_{50} values of the lyophilized powder are 7.8 µg/ml for B-1 ke and 6.7 µg/ml for B-2 90 against third instar larvae 72 h after exposure. An analysis of the immunotypes of the crystal proteins by ELISA techniques shows that these two strains may contain Cry IA(b), Cry IC and Cry IE of ICPs, however the amount of each ICP was different between the two strains.

BIOLOGY AND DEVELOPMENT OF SOME STORED GRAIN PESTS AS AFFECTED BY δ- ENDOTOXIN AND β-EXOTOXIN OF BACILLUS THURINGIENSIS. H.S. Salama, A.A. Razek (National Research Centre, Dokki, Cairo Egypt), R. Aboul-Ela, A. El-Moursy (Faculty of Science, Cairo University).

Exposure of Plodia interpunctella and Sitotroga cerealella to sublethal concentrations of Dipel 2X (R) Bacillus thuringiensis var. kurstaki-HD-1) with its spores and endotoxin crystals led to an increase in the sum of larval-pupal duration. A decrease in moth emergence, egg production, and fertility was observed with increase of Dipel 2X concentration, while the longevity of the moths was not affected by treatment. Sublethal concentrations of B-exotoxin (ABG-6162 A) had no significant effect on the sum of larval-pupal duration of either insect species. Percentage of moth emergence decreased with the increase of B-exotoxin concentrations. The longevity of both male and female adults of P. interpunctella and only of females of S.cerealella were shorter at high concentrations. Egg production in P.interpunctella was reduced by all concentrations of the B-exotoxin, and hatching of eggs was reduced by concentrations of 15 ppm. and above.

ENHANCEMENT OF THE POTENCY OF BACILLUS THURINGIENSIS AGAINST AGROTIS YPSILON THROUGH CHEMICAL ADDITIVES. M. Hafez (Faculty of Science, Cairo University), H.S. Salama, M. Ragaei (National Research Centre, Dokki, Cairo, Egypt).

Biochemical approaches have been developed to potentiate the activity of Bacillus thuringiensis, against Agrotis ypsilon These approaches were based on the incorporation of some selected non-toxic chemical compounds with different modes of action with the endotoxin fed to the larvae and thus, resulting in its potentiation. Among the compounds tested, some inorganic salts, organic acids and their salts, protein solubilizing agents, amino acids and amides showed a remarkable potentiation to the endotoxin activity against the target insect. In search for adjuvants that may enhance the effectiveness of B.thuringiensis, sucrose, molasses, chick peas, soybean powder or oil were found to improve the efficacy of B. thuringiensis against A. ypsilon larvae. Extracts of some host plants of this insect can also improve the efficacy of the pathogen. These results are undoubtedly of great value to industry and they should contribute to the significant reduction of cost production of endotoxin preparations and would render the commercial production of B. thuringiensis most economic through incorporation of these additives at a post harvest stage.

DEVELOPMENTAL STAGES OF AGROTIS YPSILON AS AFFECTED BY BACILLUS THURINGIENSIS. M. Hafez, R. Aboul-Ela (Faculty of Science, Cairo University), H.S. Salama and M. Ragaei (National Research Centre, Dokki, Cairo, Egypt).

A screening of the larvicidal activity of more than fifty strains of Bacillus thuringiensis against Agrotis ypsilon was made. The larvae showed susceptibility to some cultures of varieties thuringiensis, tolworthi,galleriae and aizawai. All the active isolates belong to varieties which are B-exotoxin producers. The prepupal and pupal stages of A.ypsilon were affected by B. thuringiensis when sprayed or kept in the soil treated with the pathogen. The emerged moths showed a short longevity associated with low egg production and low fertility. This effect was associated with the tested concentratins of B.thuringiensis. Treatment of the pupae of A.ypsilon with B.thuringiensis showed an increased effect when treatment was applied immediately after pupation. The effectiveness of B.thuringiensis against the moths and eggs of A.ypsilon have been demonstrated in laboratory experiments. The longevity, egg production and fertility were significantly affected when the moths were fed on a diet containing the pathogen at certain concentrations. Sucrose diets containing spores of B.thuringiensis only or without viable spores (UV irradiated B.thuringiensis solution) caused also adverse effects on the longevity,egg production and egg hatching, but with reduced moth mortality. Egg masses sprayed with B.thuringiensis hatched normally,but the survival of the hatched larvae was reduced when treatment was made shortly before egg hatching. Based on these results,B.thuringiensis showed a promising effect in the control of the moths A.ypsilon as well as an ovicide-larvicide agent.

A NEW VARIETY OF MILKY DISEASE, BACILLUS POPILLIAE VAR. HOLOTRICHIA, FROM HOLOTRICHIA TITANIS. He Zu-tian, Gui-ming Guo, Jian-en Hou, Tian-qi Zhao (Institute of Plant protection, Shanxi Academy of Agricultural Sciences, Taiyuan 030031, China)

A variety of Bacillus popilliae was found to cause milky disease in Holotrichia titanis Reitter (Coleoptera, Melolonthidae) in the Changzhi region of Shanxi province, China. Its sporangium measures 5.07 by 1. 30 micron, the spore 1.70 by 0.71, and the parasporal body 0.59 by 0.76 and shaped blunt diamond. The organism has a wide host spectrum, for example, H. oblita (Feld.) H. parallela Mots., Trematodes tenebrioides (Pallas), and Metabolus tumidifrons Fair can be infected easily by the methods of injection and feeding in the laboratory. Field experiment showed that after application with the bacteria powder in the dosage of 120 to 540 billion spores per mu, the number of white grubs and the rate of damaged wheat seedling was reduced by 45.6% to 56% and 68.5% to 74% , respectively.

The main characters which distinguish this strain from other varieties are its morphology, the original host insect, the host spectrum and the maximum temperture for in vitro growth. The organism is designated B. popilliae var. holotrichia.

BACILLUS THURINGIENSIS POTENCY BIOASSAY AGAINST *PLUTELLA XYLOSTELLA* LARVAE. Suey-sheng Kao, Shu-Jen Tuan (Biopesticide Department, Taiwan Agricultural Chemicals and Toxic Substances Research Institute, 189 Chung Cheng Road, Wufeng, Taichung Hsien, Taiwan, China)

A standardized bioassay protocol was developed for the evaluation of preparations derived from *Bacillus thuringiensis* against *Plutella xylostella* larvae. HD-1-S-1980 with a toxicity rating of 16,000IU/mg is assigned to be the reference standard. Prior to bioassay, the fully-grown, fresh, insecticide-free cabbage leaves (7 cm in diameter) were cut off. Five leaf-discs per concentration were sprayed two-sided by a potter spray tower. A minimum of 5 concentrations per sample are required. The leaf-discs were put into icecream cup (7.9cm dia, 5.7cm deep) (one disc per cup) on a moistured filter paper. Ten 3rd-instar larvae were added in each cup. The icecream cups were closed with a perforatd cover and kept in a growth chamber of 25±1°C, 70±3% R.H., and L:D=12:12. After 48hrs the leaf-discs were replaced by untreated leaf-discs. Dead larvae were removed and recorded every 24hrs. At the end of the bioassay (72hrs post-treatment), the total death was recorded. The mortality was corrected according to Abbott's formula and LC50 was assessed by computer-aided probit analysis. Potency of the sample can be calculated according to the following equation: Test sample (IU/mg) = (LC50 standard / LC 50 sample) X Potency of HD-1-S-1980 (16,000 IU /mg). A minimum of 3 bioassays are required to conclude a bioassay series. And, 3 assays should produce an average potency value with an associated standard deviation that yields CV<20 %.

#1

SELECTION OF THE SUPERIOR STRAIN OF BEAUVERIA BASSIANA AND ITS ESTERASE ISOZYMES. Fengming Yin, Quancai Chen (Forest Research Institute of Guangdong, China)

The strain No.11 was selected among 31 Beauveria bassiana strains created from the Beauveria Bassiana spore which was radiated with CO_2 laser. The strain No.11 had such characteristics as 25-33% increase of output, 43-45 days shortening of culture duration, 20% increase of successful pest control. The strain No.11 was detected to have 9 esterase isozymes, among which were 3 strong isozymes, 3 less strong, 3 weak. The esterase isozymes of the radiated strains were different from these of original ones. Some radiated strains had added isozymes and activity of esterase was increased. The other had fewer isozymes and esterase activity was reduced, or unchanged with the variance of Rf.

#2

The Effect Of Diphenol On The Growth Of Three Entomogenous Fungi. Wen-Feng Hsiao, M. J. Bidochka and G. G. Khachatourians (Bioinsecticide Research Laboratory, Dept. Applied Microbiology & Food Science, Univ. Saskatche-wan, Saskatoon, SK S7N 0W0, Cánada)

There are many diphenols found as part of the insect cuticle or hemolymph. During their encounters with insects, entomogenous fungi will interacts with such diphenols. In this poster presentation, the growth of three entomopathogenic fungi, *Verticillium lecanii*, *Beauveria bassiana* and *Metarhizium anisopliae* was determined in a yeast extract-peptone-dextrose (YPD) medium or a defined medium supplemented with diphenols: dihydroxyphenylalanine, dopamine, dopamine-HCl, norepinephrine-HCl, dihydroxyphenylacetic acid or catechol. These diphenols may be found as part of the insect cuticle or hemolymph. Without diphenols YPD medium afforded generally higher growth of the fungi when compared to defined medium. Lowest grown was observed for *B. bassiana* and *M. anisopliae* in defined medium supplemented with dopamine, dopamine-HCl or norepinephrine-HCl. Best growth for *B. bassiana* or*M. anisopliae* and *V. lecanii* in defined medium was observed in unsupplemented medium or medium supplemented with dihydroxyphenylacetic, dihydroxyphenylalanine or catechol.for the first two fungi and in defined medium supplemented with dopamine, dopamine-HCl or norepinephrine-HCl for *V .lecanii* . Growth of *B. bassiana* and *M. anisopliae* was inhibited in YPD medium containing catechol while dihydroxyphenylanine stimulated it. While *M. anisopliae* and *B. bassiana* response to various diphenols have certain similarties therefore *V. lecanii* was different. The results will be discussed with reference to fungal growth on whether saprophytic or not on host insect .

#3

PREVALENCE OF ERYNIA RADICANS (ZYGOMYCETES :ENTOMOPHTHORALES) IN HOMONA MAGNANIMA (LEPIDOPTERA :TORTRICIDAE) LARVAE ON THE TEA FIELD IN TOKYO. Kunimi,Y., Mao, H. and Tanaka, H. (Dept. Appl. Biol., Fac. Agric., Tokyo Univ. Agric. and Tech., Saiwai-cho, Fuchu-shi, Tokyo 183, Japan).

Infection rates of Erynia radicans were monitored from 1988 through 1990 in natural population of the oriental tea tortrix, Homona magnanima on the tea field in Tokyo. Although larvae infected with E. radicans were observed on the tea field throughout the year, percentage prevalence at each generation varied between 0 and 45. Infection prevalence was always higher in old larvae than young larvae. Stepwise multiple regression analysis was utilized to attempt to determine the relationship of prevalence levels of E. radicans at each generation (PE:%) to four independent variables; average temperature (AT:°C), total rainfall (TR:mm), population density of larvae (DL:/m^2), prevalence of viral disease (PV). The PE was positively correlated with TR and DL but negatively correlated with AT. The PE could be described by the following equation; PE = 0.066TR + 1.038DL - 2.068AT + 31.1 ($r = 0.98$, $P<0.01$). The PV did not appear to be as important in prevalence levels of E. radicans.

#4

EXTRACTION AND HOMOGENY OF LARVICIDAL TOXINS IN BACILLUS SPHAERICUS STRAIN C_{3-41}. Zhi-hong Zhou, Yong-mei Zhang and E-ying Liu (Wuhan Institute of Virology, Academia Sinica, Wuhan 430071, China)

Spore-crystal toxin, spore-wall toxin and crystal toxin of Bacillus sphaericus C_{3-41}(Chinese strain) were extracted respectively from spore complex. When subjected to SDS-PAGE, both spore-crystal toxin and crystal toxin might give two toxic protein bands (43 and 40 kilodaltons), but spore-wall toxin had only a protein band (MW 104 KDa), which was degraded into toxic 43 and 40 KDa proteins by using NaOH.

The LC_{50}Values of spore-wall toxin and sporecrystal toxin purified by Sephadex G-75 were 267 and 10 ng/ml respectively against the third instar larvae of Culex quinquefasciatus at 48 hours.

The results of immunodiffusion showed that sodium hydroxide-solubilized toxic proteins from spore comples of strain 2362, 1593, BS-10 and 2297 produced cross reactions with 43 and 40 KDa antiserum of strain C_{3-41}, but those of strain KQ(H_1), SSII-1, 1404(H_2) and 2315(H_{2i}) did not produce cross reactions with the same antiserum.

It was showed that spore-wall toxin, spore-crystal toxin and crystal toxin of strain C_{3-41} were homogeneous for antigenictiy.

#5

PURIFICATION OF A HEAT STABLE SOMATIC ANTIGEN FROM THE VEGETATIVE CELLS OF Bacillus thuringiensis. Sekijima,Y.,Y.Fujikura (Laboratory of Serology and Immunology,Saitama College of Health,Urawa 338,Japan), Y.Tsumuraya, Y.Hashimoto, N.Yamada, and S.Kikuchi(Department of Biochemistry,Faculty of Science,Saitama University, Urawa 338, Japan)

The vegetative cells of Bacillus thuringiensis produced a heat stable somatic antigen (HSSA), which was subspecies-specific or group-specific. This antigen was purified from the disrupted vegetative cells of Bacillus thuringiensis subsp.thuringiensis by precipitation with 3 volumes of acetone,chromatography with DEAE-cellulose, gel-filtration on Sepharose CL-6B and rechromatography with DEAE-cellulose. Up to 8 mg of HSSA was purified from 100 g (wet weight) of culture pellet. Purified HSSA had a molecular weight of approximately 95,000 by gel filtration on Sepharose CL-6B with molecular weight markers. Additon of purified HSSA contained 30.5% neutral sugars and 5.2% amino sugars respectively, consisting of 50.6% mannose, 36.4% galactose and 13.0% glucosamine. By the electrosyneresis with specific antiserum to B.thuringiensis subsp.thuringiensis, 5 µl of purified HSSA (0.1%) had 6,500fold titers. Furthermore this antigen was able to activate complement system in human serum, via the alternative pathway.

#6

HISTOPATHOLOGICAL STUDY OF CULEX QUINQUEFASCIATUS LARVAE TREATED WITH BACILLUS SPHAERICUS STRAIN C_{3-41}. Zhoug-shu Xu, Yong-mei Zhang, E-ying Liu (Wuhan Institute of Virology, Academia Sinica, Wuhan 430071, China)

The histopathological changes in the midgut of Culex quinquefasciatus larvae treated with Bacillus sphaericus strain C_{3-41} were observed by light microscope and electron microscope.

The results showed that the epithelial cells of the larval midgut swelled, sloughed and disrupted subsequently, but the basement membrane of the cells and the peritrophic membrane remained intact. When the epithelial cells were disrupted, the caecal cells were also dameged.

The lysosomes in the epithelial cells of the larval midgut increased in quantity and size after three hours. The mitochondria were influenced after six hours, including dilation of cristae, increase of electron density and destuction subsequently. In the meantime, the endoplasmic reticula swelled or disrupted, and the basal infolding of the basement membrane formed vacuoles. The tesions of the skeletal muscle in the larvae treated were also observed.

#7

THE INFLUENCE OF PH ON THE PATHOGENICITY OF CRYSTALS OF BACILLUS THURINGIENSIS. Cha-yun Sha, Shu-fang Chang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

This paper dealt with crystals of five Bacillus thuringiensis 457(H_1), HD-1(H_{3a3b}), T_{84-1} (H_{4a4c}), 10-4-13 (H_9), T_2 (H_{22}) digested by the gut juice of armyworm (Mythimna separata) and yellow mealworm (Tenebrio molitor) at pH 6.4, 7.4, 8.4 and 9.4 to incubate at 30°C for 6 hours. And the supernatants and precipitates were carried out bioassay on 3rd instar larvae of armyworm and yellow mealworm respectively. The results showed that the supernatants and precipitates of T_{84-1} and T_2 are not toxic to armyworm. Whereas the supernatants and precipitates of 457, HD-1 and 10-4-13 were toxic to armyworm. And for yellow mealworm all these preparations have no effect. Crystals have little solubility at pH 6.4 and 7.4. At pH 8.4 crystals could be digested but less than at pH 9.4,

The results demonstrated that pH played an important role in digestion of crystals, and also showed that different crystals have a diverse constructions.

#8

Comparision of the morphology of phase one and phase two bacteria of Xenorhabdus nematophilus isolated from the insect parasitic nematodes Steinernema carpocapsae Umeå and Torneträsk strains. (Li, W., and M. Burman, Department of Zoophysiology, University of Umeå, Sweden).

The obligate symbiotic bacteria Xenorhabdus nematophilus Umeå and Torneträsk strains are isolated from two insect parasitic nematodes found in northern Sweden. Each of them occurs in two appearences: phase one and phase two. The phase one bacterium forms green blue colonies on bromthymol blue triphenyltetrazolium chloride with tergitol-7 agar plate (TTC&T-7). On nutrient agar plate (NA), it forms yellow colonies. The phase two colonies formed on TTT&T-7 are red. On NA, they are cream white and flattened. The lengths of phase one bacterium are rather variable, phase two cell's lengths are uniform. The mean length of phase one cell of Umeå strain is 3.83μm±1.27 (SEM); Torneträsk, 4.01μm±1.22; phase two cell of Umeå strain is 1.70μm±0.35; Torneträsk 1.83μm±0.48. The occurence and distribution of flagella on the bacteria were examined by transmission electron microscope. The phase one bacterium has peritrichous flagella, and the phase two bacterium has lophotrichous flagella. The differences between the two bacterial phases in size and in flagella occurence may influence the bacterial retention in the infective juveniles of the nematodes.

#9

Characterization of Polyhedrin of Spodoptera litura Nuclear Polyhedrosis Virus (SlNPV)

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**Dae Joon Im, *Seok Kwon Kang
(*College of Agriculture and Life Science, Seoul National Univ. Suwon, KOREA. **Department of Entomology, Agricultural Sciences Institute, RDA, Suwon, KOREA.)

To control tobacco cutworm, Spodoptera litura, which is an important pest in southern part of South Korea, we have studied to develop SlNPV as a broad host-range viral insecticide.
Polyhedrin, a major protein in the polyhedron, has an important role of protecting viral particles from environmental inactivating factors. Some chemical properties of polyhedrin of SlNPV was characterized by SDS-PAGE, amino acid analysis, and serological methods. The influence of alkaline protease in larval gut-juice on the polyhedrin was tested. And also the polyhedrin gene was cloned and sequenced.

#10

SOIL APPLICATION TRIALS OF AGROTIS SEGETUM NPV AS A CONTROL AGENT OF AGROTIS SEGETUM LARVAE. M.R.V. de Oliveira (EMBRAPA /CENARGEN, Cx. Postal 02372, CEP 70840, Brasília, DF, Brazil), P.F. Entwistle (Institute of Virology and Envirironmental Microbiology, Mansfiel Road, Oxford, OXFDS. OX1 3SR, UK).

Agrotis segetum (Denis & Schiff.), the turnip moth, have the habit in the larval stage, of cutting the stems of seedlings at ground level and, latter on, when the larvae are more mature, move underground to damage roots. Investigation were carried out to determine the optimaltime of presentation of nuclear polyhedrosis virus (NPV) to the host insect, this is, on the soil surface or mixed in soil. Treatment of soil with the AsNPV was examined in five different ways: 1 - contaminated soil was placed on the soil surface of the pots; 2 - contaminated soil was placed 1cm below soil surface and covered with 1.50cm of uncontaminated soil; 3 - contaminated soil was placed on top of seeds and corred with 2.5cm of uncontaminated soil; 4 - contaminated soil surface, plus a combination of spraying; 5 - contaminated soil was placed 1cm below soil surface, and spraying. Soil trials responded in a satisfactory way, revealing the value of NPV application to soil to the development of epizootics. Surface contamination and the combination of top soil contamination plus spraying resulted in high levels of mortality.

#11

STUDY ON ANDRACA BIPUNCTATA GRANULOSIS VIRUS AND ITS APPLICATION

Jin-xiu Chen Yong-guan Ding De-jin Xu Dong-fang Zhang (Plant protection Institute, Anhui Academy of Agricultural Sciences, Hefei 230031, China.)

Tea bunch caterpillar (Andraca bipunctata, Walker) is one of tea-devouring pest insects in China. A virus pathogen which causes A. bipunctata epidemic disease was discovered first by authers in 1980. The virus belongs to Baculovirus, subgroup B, and was named the Andraca bipunctata Granulosis virus(AbGV).
The LC50 of AbGV suspension to the 3rd-instar tarvae was $1.23X10^7$ mg/ml, and LT50 ranged from 4.2 to 8 days. The results from room trials showed that 1st instar tarvae were the most susceptible to the virus, the mortality decreased with the increase of the tarval instars; the effectiveness of AbGV increased with the concentration increase of the virus. AbGV was found safe to beneficial insects. When AbGV preparations were applied in tea gardons, the results showed that the best stage to spray the virus were in 1st and 2nd instars. the effective dosage was 1500-3000 mg per ha.. The controt effects in different generations ranged from 79.5 to 97.45%. A combined use of AbGV with a low dose of chemical insecticide proved marked synergistic effect. The virus after-effect in tea gardon tasted over 2 years, with natural mortalities of A. bipunctata kept beteen 18.76—55.94%, which proved that AbGV was an important agent in suppressing A. bipunctata on a long basis in coordination with other natural enemies.

#12

BIOCHEMICAL AND BIOPHYSICAL CHARACTERIZATION OF THE GENOMIC NUCLEIC ACID OF THE COTTON BOLLWORM CYTOPLASMIX POLYHEDROSIS VIRUS HaCPV-PEKING ISOLATE. Hong-sheng Lü, Ji-fang Qian, Min Zhang (Institute of Plant Protection, Chinese Acad. Agr. Sci., Beijing 100094, China) Li-ming Tao, Jia-lu He (Sericultural Research Institute, Chinese Acad. Agr. Sci., Zhenjiang 212018, China)

The nucleic acid was extracted from this virus by hot SDS-phenol method and precipitated in a jillylike form in cold ethanol. The UV aborption curve in 1xSSC was typical for RNA, A258.4/A232=1.851. Hyperchromicity measured in 0.5x SSC after reacting with formaldehyde at 37℃ for 16hr was 47.58%. Tm measured in 0.1xSSC was 79℃. In addition, the greenish-yellow colour was observed under flurescent microscope when virus polyhedra were stained with acridine orange. Above results indicated that the secondary structure of genomic RNA was double-stranded both in 1xSSC and in intact virons naturally. Genomic dsRNA was separated into 10 bands by 2.5% polyacrylamide gel disc electrophoresis. and the 1st, 5th, 6th, 7th and 10th band apparently contained more than one dsRNA segments with similar MW and migration rate. Thus, the genome fo HaCPV-peking isolate was consisted of 15 dsRNA segments. the MW of each segment was ranged from 2.47 to $0.54x\ 10^6$ daltons and the tolal MW of genomic dsRNA was $19.77x10^6$ daltons, indicating this isolate was differ from others in genome profile.

#13

A STUDY ON THE NUCLEAR POLYHEDROSIS VIRUS OF THE LYMANTRIID, PAROCNERTA ORIENTA CHAO. Shun-li Chen, Yougong Li, Bao Cheng (Fujian Forestry College, Fujian 353001, China)

In 1988,a Nuclear Polyhedrosis Virus of Parocneria orienta Chao was isolated in Nanping, Fujian Province, China. By scanning electron microscope it was showed that the inclusion body is a hexahedron, with a diameter of 0.61-2.69 μm. The virus is singly embedded with rod-shaped and a size of 48-72×320-376 nm. Early second-instar larvae were fed on Chinese weeping cypress leaves contaminated with polyhedral inclusion bodies(PIB) of the virus. The regressive equation between concentration and mortality was y=3.290+0.361x. The LC50 and 95% fiducial limit were 5.455×10^4 PIBs/ml and 1.837×10^4-1.614×10^5PIBs/ml, respectively. The LT_{50} for the virus concentration of 4×10^4, 4×10^5, 4×10^6, 4×10^7 and 4×10^8 PIBs/ml were 12.29, 8.87, 7.97, 6.88 and 6.05 days, respectively. Tests of larval susceptibility to a concentration of 4 10 PIBs/ml of virus suspension indicated that mortality decreased as the larvae grew from 89.5% of second-instar larvae to 67.07% of fifth-instar larvae. The LT_{50} increased with the increase of instar, from 6.88 days of second-instar larvae to 8.45 days of fifth-instar larvae. Temperature had no influence upon the total mortality but it did affect the death rate.

#14

EFFECTS OF GMNPV SUBLETHAL DOSED ON MALE AND FEMALE LYMANDRIA DISPAR LARVAE. Tsuey Ding (Institute of Zoology, Academia Sinica, China), Michael Ma (Department of Entomology, University of Maryland, U.S.A.)

Newly molted 5th-instar larvae of Gypsy moth, Lymantria dispar, were infected with a GMNPV suspension of known concentration: 1.3×10^4 -10^6 PIBs/ml. The experimental results demonstrated that sublethal doses of GMNPV not only cause the death of some individuals, but also effected pupal number, sex ratios of male and female. Mortality of male and female larvae for virus concentration of 1.3×10^4, 1.3×10^5, 1.3×10^6 PIBs/ml were 1%, 3%, 4% and 4%, 7%, 9%, respectively. In general, sex ratios are in favor of male. The pictures of ultra-section showed that fat body, tracheal matrix ganglion, brain, ovary and prothoracic glands of female of Gypsy moth were infected by GMNPV. The result about brain, ovary and prothoracic glands infected by NPV may provide some evidences for developmental delay of female larva.

Polyhedra existed in nuclei of infected cells display strong reaction with antibody of GMNPV using immunogold-labelled technique.

#15

STUDIES ON SOME CYTOPLASMIC POLYHEDROSIS VIRUSES. Zhi-rong Chen, Xiu-yu Cai(Institute of Zoology, Academia Sinica, Beijing 100080 China)

A new cytoplasmic polyhedrosis virus, HaCPV, was isolated from tobacco budworm(Heliothis assulta). HaCPV as well as cytoplasmic polyhedrosis virus of Agrotis segetum (AsCPV) were characterized. By SDS PAGE, the major polypeptides(polyhedrin) in polyhedral proteins from HaCPV and AsCPV showed a molecular weight of 23000 and 22500 daltons respectively. No carbonhydrate was detected in the polyhedrins from both viruses by staining analysis. Nucleic acids extracted from polyhedral bodies or virus particles of HaCPV and AsCPV were DNase I-resistance and considerably RNase-resistance suggesting HaCPV should be classified with AsCPV as a doublestranded RNA virus. Nine bands were resolved when the nucleic acid from HaCPV was electrophoresesed on 1% agarose. Since the fluorescent intensity of band 2 was much higher than the others, most likely, this fraction contained two RNA segements with similar size. Therefore, the genome of HaCPV consisted of 10 RNA segements with a total molecular weight of 15.85×10^6 daltons. As for AsCPV, seven bands of intensive stained with EB bands 1.5 and 7 were considered to contain RNA segments. The molecular weight of AsCPV genome of 10 pieces RNA was estimated to be 14.95×10^6daltons.

#16

STUDIES ON THE ULTRASTRUCTURE AND REPLICATION CYCLE OF THE HaCPV-PEKING ISOLATE. Xi-xia Luo, Qing-guo Xi, Cangsheng Fu*, Ji-fang Qian, Hong-sheng Lü (Institute of Plant Protection, Institute of Atomic Energy Utilization,* Chinese Acad. Agr. Sci., Beijing 100094, China)

Virions were 45 nm in diameter with 12 spikes on the icosahedral particle. Pentagonal polyhedra had an average diameter of 3.67μ, ranging from 1. 25-7.08μ. The primary invasive virions were observed to enter midgut columnar cells at the microvilli via injection of core substance into cytoplasm through spike at 5 minutes pi. The empty capsid remained on the surface of microvilli and the core substance migrated in cytoplasm to ward nucleus. the first overt signs of infectiong appeared to be increasing the volume and number of nucleoli and subsequently acumulation of pyroninophilic substance in nucleus and cytoplasm. Then, discrete lobular virogenic stroma formed in cytoplasm at the apical regions. In contrast to NPV, polyhedra formed not only in " ring zone " but also in the central area of VS. As infection progressed, a continuous production of progeny virions and polyhedra occured in newly formed VSs locating in middle and basal portions of the cell. Finally, apical membrane raptured, polyhedra and virions released. CPV infection began in posterior midgut then gradually spread to anterior, demonstrating the diversity in susceptibility to CPV infection within columnar cell population.

#17

IMPROVEMENT OF DISPENCERS FOR VIRAL INSECTICIDES. Voloschuk, L.F., Cukhrii, M G. (All-Union Research Institute of Biological Methods of Plant Protection Kishinev 277060, U.S.S.R.)

Though Baculoviruses are highly ressistant to environmental factors their use as pure preparation results in sharp reduction of preparations bioactivity. This fact promotes application of complex compositions whose ingredients can provide formation of resistant suspensions and reliable protection from infavourable influence of environmental factors.

The dispencers must include components which can provide the most effective parameters to protect viral infection and which can be rapidly decomposed. These components were included into dispencers for developed by us viral insecticides against *Heliothis armigera, Hyphantria cunea, Lymantria dispar, Mamestra brassicae, Leucoma salicis* and *Carpocapsa pomonella.*

#18

MORPHOGENESIS OF BACULOVIRUSES INFECTING LEPIDOPTEROUS PLANT PESTS. Cukhrii, M.G., Voloschuk, L.F. (All-Union Research Institute of Biological Methods of Plant Protection, Kishinev 277060, U.S.S.R.)

Baculcoviruses infecting lepidopterous pests are characterized by complex morphogentic processes whcih can be divided into 10 stages: 1. virus penetration into the intestinal cavity, where protein supracapsides dissolve(polyhedra or granules);2. the release of virions from supraviriocapsids (SVC) or suprapolyviriocapsids((SPVC); 3. virion penetration into micovillae of pillar cells of the intestinal epithelim; 4. formation of viroplasts and the synthesis of big groups of nucleocapsids in epithelial cells of the intestine; 5. nucleocapsid transportation into other insect tissues; 6. secondary infection of insect tissues cells; 7. formation of the viroplast and nucleocapsids; 8. formation of virions and envelopes; 9. virus structuring: unclusion of virions into protein SPVC;10. formation of envelopes of SPVC and SVC.

#19

EFFECT OF THE NUCLEAR POLYHEDROSIS VIRUS FROM TEA GEOMETRID (ECTROPIS OBLIQUA HYPULINA) ON ITS HOST FEEDING, GROWTH, DEVELOPMENT, REPRODUCTION AND POPULATION DYNAMICS. Gong-yin Ye and Cui Hu (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China), Jun-qing Zhu and Jiang-nong Shang (Hangzhou Tea Research Institute, Yuhang, 311115, China)

The tea geometrid, Ectropis obliqua hypulina Wehrli is an important pest of tea bush in East China. Compared with the healthy ones, the food consumptions, feeding periods, larval staida, pupal spans and pupal weights of the larvae fed with the nuclear polyhedrosis virus from the tea geometrid (EoNPV) at the beginning of different instars were investigated, the nutritional indexes of the larvae fed with EoNPV at the beginning of 4th instar were measured, and also ovarial development rate and reproductive characteristics such as mating rate, egg-laying, fecundity and total egg number of the adult survived from the viral infection were observed. In addition, the suppression of EoNPV on the tea geometrid population dynamics under different conditions was evaluated.

#20

THE, STUDY ON THE SMOKYBROWN COCKROACH (PERIPLANETA FULIGINOSA) DENSOVIRUS. Huang Yuanda*, Hu Yuanyang**, Zhang Jiamin**, Yao Ermei**, Wang Fangan*, Liang Dongrui** (Wuhan Grain Industry College*, Wuhan University**, Wuhan, **China** 430022)

We found and isolated Periplaneta fuliginosa Densovirus (Pf DNV) in 1990 and did back infection experiment according to Koch's Hypothesis. The result: the virus separated from the Periplaneta fuliginosa resulted in the same disease symptoms, still the same virus was isolated. The virus had powerful infection effect. Although it's LT50 was 39 days, the final percent of dead Periplaneta fuliginosa reached 99%. All these show: the DNV is the pathogen of Periplaneta fuliginosa.

The biophysical and biochemical properities of the virus were characterized. Purified virion is isosahedral spheroid with the diameter 20nm, the sedimentation coefficient 102s, the density 1.40g/cm3. It's nucleic acid is linear ssDNA with the length 1.7μm and MW 1.7×10^6d. The structural protein is composed of 4 kinds of peptide with molecular weights 84k, 64k, 55k and 29k. According to the viral taxonomic principle, this virus belongs to Densovirus, Parvoviridae. We name it Periplaneta fuliginosa Densovirus, simplified as PfDNV.

The find and research of PfDNV have great theoretic and applical worth.

#21

ISOLATION AND NUCLEOTIDE SEQUENCES OF *PERINA NUDA* MULTIPLE NUCLEOCAPSIDS NUCLEAR POLYHEDROSIS VIRUS (PnMNPV) TWO LATE GENES: POLYHEDRIN AND p10 GENE. **Jly-Ming Chou, Chu-Fang Lo** (Zoology Department, National Taiwan University, Taipei, Taiwan, China), **Chang-Jen Huang** (Institute of Biological Chemistry, Academical Sinica, Graduate Institute of Biochemical Sciences,Taipei, Taiwan, China), **Chung-Hsiung Wang** (Graduate school of Biology, Fu-Jen University, Taipei 242205, Taiwan, China)

Perina nuda multiple nucleocapsids nuclear polyhedrosis virus (PnMNPV) was a member of subgroup A baculovirus. PnMNPV had a circular double stranded DNA genome of 120 kilobase pairs. By polymerase chain reaction, the probes containing part of AcMNPV polyhedrin and p10 gene coding region were prepared for the isolation of PnMNPV p10 and polyhedrin genes from the mini-library of PnMNPV DNA PstI fragments with these probes. The nucleotides sequences of these two late genes were determined. By comparing the PnMNPV polyhedrin DNA sequences with other NPV, it showed that the polyhedrin gene was highly conserved, We found the two late genes of PnMNPV were very similar to OpMNPV, but they had different restriction profiles.

#22

SCREENING METHODS FOR BACULOVIRUS RECOMBINANT VIRUS. **Nai-Yueh Tien, Chu-Fang Lo, Guang-Hsiung Kou** (Department of Zoology, National Taiwan University,Taipei, Taiwan, China)

A *Autographa californica* multiple-nucleocapsid nuclear polyhedrosis virus (AcMNPV) recombinant transfer vector which contained a foreign gene-Hepatitis B virus surface antigen gene (HBsAg) was constructed and cotransfected with wild-type AcMNPV genome DNA into insect cell line-IPLB SF 21-AE. After successful cotransfection, a series of quick screening methods were established for the purification of the recombinant virus from cotransfection fluid. The methods included dot-bot, hybridization with DIG-labelled probe, polymerase chain reaction (PCR) and observations of recombinant virus morphological characterstics. The results showed that with applications of these virological, molecular biological and morphological technologies, the recombinant virus could be purified quickly and correctly.

THE STUDY ON PATHOLOGY OF *OSTRINIA FURNACALIS* AFTER INFECTION WITH *BUEAVERIA BASSIANA*. Ai-Wen Zhang, Chun-sheng Deng, Xiang-qiun Nong (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing, 100081, China), Shu-xian Ren, Cong-ren Xu (Department of Biology, Beijing University, Beijing 100080, China)

The pathological processes in the bodies of *Ostrinia furnacalis* after infection with *Bueaveria bassiana* are reported in this paper. Along with the development of insect instar, the infecting speed of *B. bassiana* to the host and the disintegrated speed of insect tissues are reduced. The whole period of the germ tube or hyphae passing through the cutex and entering the hemolymph and lipode of host needed 36 hrs to 1-2 instar larvae, and 46-51 hrs to 3-4 and last instar larvae. The damage and the disintegration of insect tissues happening during the periods after inoculation, need 42-48 hrs to 1-2 instar larvae, 72-96 hrs to 3-4 instar larvae, and 120-140 hrs or longer to the last instar larvae. The infecting sequences of hyphae to various tissues of host can be divided into four stages: 1. cutex, 2. hemolymph, lipode, 3. alimentary tract, malpighian tubule, silk gland and reproductive gland, 4. muscle, silk gland duct and nerve cord. The pathological changes of insect tissues can be briefly described as follows: the appearing of vague edges, crevices and empty circles around or among tissues then the happening of damage and disintegration of them.

A STUDY ON THE HISTOPATHOLOGY OF OSTRINIA FURNACALIS (GUENEE) INFESTED WITH BACILLUS THURINGIENSIS. Xinyin Li (Institute of Plant Protection, Hebei Academy of Agricultural Sciences, Bao Ding 071000, Hebei, China)

Both external and internal pathologic changes of Asian corn borer (O. furnacalis) larvae infested by sub-lethal dose of B. thuringiensis (Bt) were reported in this paper. The 2nd instar-larvae of corn borer were fed with different doses of Bt mixed in artificial diet for 5 days. The larvae treated with high dosed died, and the larvae treated with lower doses kept to live, but stopped feeding. They also showed extremely lower activity and slower growth and development than the untreated healthy ones. The average body length and weight of untreated larvae were 4.6 and 7.1 higher than the treated ones, respectively.

In order to examine the histopathologic changes of corn borer larvae infested by Bt, 4th instar-larvae were fed with artificial diet containing 75μg (Bt)/g for 16 hours. The larvae that showed some visible symptom were collected and their midguts were dissected out for observation with electron microscope. In the midguts of infested larvae, the epithalial cells (including collummar cells and goblet cells) were deformed. The microcelli on epithalium became disarranged, swelled and sloughed. In the epithalical cells, the mitochondria swelled and cavities occured inside. Morever, the reticulum and xitosomes lessened and the epithalial cells desolved at last.

STUDIES ON THE GRANULOSIS VIRUS "OFGV-01" FROM THE ASIAN CORN BORER OSTRINIA FURNACALIS GUENEE AND ITS UTILIZATION. Yong-Sheng Yin, Jin-yu Chang(Insititute of Sorghum, Shanxi Academy of Agriculture yuci 030609, China) Mei-yun Pei, yan Qiu (Institute of Microbiology, Academia Sinica, Beijing 100800, China) Yan-gui Wang, wei-jing Liu(Department of Microbiology Shanxi Medical College, Taiyuan 030001, China)

A new species of virus(OFGV-01) was seperated form infecting larvae of Asian Corn Borer (ACB) Ostrinia furnacalis. The shape of capsules are oval, their size is about 200-350 × 240-280nm. There are one or a pair of virus particles in each capsule, the size of virus particles is about 195-200 × 186-188nm. The virus paritictes are baculiform, obtuse-round at both ends, slight or no bending. Under 24-26℃ and 73-78% R.H., the pathogenicity of virus to ACB larvae are highe. Infection of young larvae in 3-6, 9-10 and 15 days old by the virus suspension with a concentration of 1.5 × 10 GV/ml resulted in larvae died in 4th, 6th and 9th days after treated, and their mortality were 100%, 98.3% and 85.5%, respectivelty. The virus "OFGV-01" is belong to "B" subgroup of genera Baculovirus and family Baculoviridae, its specific name is "Ostrinia furnacatis granulosis virus", short as "OFGV-01". The new virus "OFGA-01" had no effect on natural enemy of ACB, such as Trichogramma evanescens Westood and Macrocentrus linearis Nees. In addition, Bioassay conducted in the laboratory showed that the virus "OFGV-01" cause not infection to various vertebrate experimental animal (include little palerat, big palerat, guinea-pig and rabbit, ect.)

PATHOGEN OF ENTOMOPHTHORALES IN SHANDONG PROVINCE. Wei-ming Wang, Wen-hua Lu (Institute for Application of Atomic Energy, Shandong Agricultural Academy, Jinan 250100, China)

The article reports the 18 species of Entomophthorales isolated from dead bodies of aphids, mosquitoes, flies and other insects in Shandong Province, China. According to Noebatkoan classifications system, they belong to 6 genera, in which 6 species of Conidiobolus, 5 species of Erynia, 2 species of Entomophthora, 2 species of Entomophaga, 1 specie of Triplosporium, 1 specie of Tarichium were included. Three species of them (i. e. Conidiobolus papillatus, Erynia nouryi, Tarichium cyrtoneurae) are new record in China and Erynia luyuan is a new species in the world. In addition, we observed 16 times of epidemic disease on aphids caused by Entomophthorales fungi on 8 crops at 11 cities and counties in Shandong Province within a few years. In general, the parasitic ratio was about 30%, a few went up to above 40%. And we also found that the occurence of the epidemic disease related to the special climate in the field and the density of aphids. Also we estimated that 450 day degree of effective accumulated temperature was needed to cause Entomophthorales disease.

ADVANCE OF BIOLOGICAL CONTROL IN CHINA IN THE PAST DECADE. Zheng-Chu Ye & Ren WANG (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

Important progresses have been made in research and implementation of biological control techniques against agricultural pests in the past ten years in China. A national-level biological control program was implemented through a centralized research and extention network., which was supervised and finantially supported by the State Planning Commission and the Ministry of Agriculture, organized and coordinated by the Biological Control Laboratory of Chinese Academy of Agricultural Sciences and the General Station of Plant Protection of the Ministry of Agriculture. A successful nationwide survey of the natural enemies of major agricultural pests was completed during 1979-83. Active international cooperation was reflected in the exchange of 370 species/shipments of live biological control materials with 26 countries during 1981-1991. Biological control was applied in a total area of 20,000 ha in 1991. Conservation and augmentation of indigenous parasites and predators with strategies suitable for the local conditions has become a key component of IPM systems and the current trend of biocontrol in China. A semi-mechanized production line with a capacity of producing 1,056,000 artificial eggs per day was developed to produce 30,000,000 ***Trichogramma dendrolimi*** or 18,000,000 ***T. chilonis*** daily. In the development of microbial agents, the annual production of ***Bacillus thuringiensis*** has increased from 300 tons in 1985 to over 4,000 tons in 1991. Using ***Heliothis armigera*** and ***Plutella xylostella*** as the standard testing insects in bioassay, the evaluation of the B.t. efficacy was standardized. Two standared B.t. products, CS_{3ab}-86 and CS_{5ab}-87 were prepared. A new "liquid-to-solid" fermentation technique was developed for the mass production of ***Beauveria bassiana***, with an average of $1X10^{11}$ pure spore/g contained in the product. Large scale field trials of aerial spraying of a wetable powder preparation of ***B. Bassiana*** to control ***Ostrinia furnacalis*** on corn were carried out in Liaoning Province with over 70% control effect. Over 10 different insect viro-pesticides were studied and tried in ca. 1,000 ha.. Through a cooperative effort with CSIRO of Australia, the entomopathogenic nematode ***Steinernema feltiae*** was mass produced and applied in large areas to control the key apple pest ***Carposina niponnensis***, the shade tree borers ***Cossus formosana*** and ***Zeuzera aultistrigata***.

PROGRESS IN CLASSICAL BIOLOGICAL CONTROL.

Jeff Waage (International Institute of Biological Control, Ascot, Berks SL5 7TA, UK)

A decade ago, it was popular to debate whether classical biological control was an art or a science. That this should be an issue after 100 years of application revealed the sorry state of a methodology which, despite decades of "contributions" from theoretical ecologists, still operated in a scientific vacuum. Today, prospects are brighter, with research increasingly realigned to address practical needs. Scientific progress, however, will mean little if scientists do not address as well today's environmental and regulatory issues in classical biological control, and thereby create for it a broad base of public support.

MODELS FOR THE MANAGEMENT OF INSECT PATHOGENS IN IPM SYSTEMS. G. C. Brown (Department of Entomology, University of Kentucky, Lexington, KY 40546, USA)

Traditionally, research on pathogen use in insect pest management has concentrated on inundative releases (microbial insecticides). While this approach has met with some success, one problem is that it usually anticipates only the control of the target generation on which it is applied. However, over the last decade, a growing body of research has begun to appear concerning inoculative releases and conservation or enhancement of various entomopathogens which typically target future pest generations. Because this approach requires understanding and the ability to manipulate complex interactions inherent in the population biology of pathogens and their hosts, it demands a strong systems/modeling methodology.

This presentation reviews the applied modeling literature on the use of insect pathogens in IPM with particular emphasis on epizootiological models aimed at incorporating pathogens in IPM strategies and decision-making. The review includes modeling methods used, types of pathogens modeled (successfully and unsuccessfully), decision criteria derived from models and their application under conditions of uncertainty.

A SYSTEMS APPROACH TO DEVELOPMENT OF A BIOLOGICAL CONTROL PROGRAM FOR WESTERN FLOWER THRIPS, *FRANKLINIELLA OCCIDENTALIS* (PERGANDE) ON GREENHOUSE SWEET PEPPER. G. H. Whitfield, J. L. Shipp and N. Zariffa (Agriculture Canada, Research Station, Harrow, Ontario. N0R 1G0, CANADA)

Western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), is a major thrips pest of greenhouse vegetables (cucumber and sweet pepper) in North America and Europe and is often present in commercial greenhouses. This pest can be controlled using the biological control agents, *Amblyseius cucumeris* (Oudemans) (predatory mite) and *Orius ssp.* (predatory anthocorid). However, in North America many growers still use chemical pesticides for control of WFT. A systems approach was used to design and conduct research into predator-prey relationships for development of adequate methodology in assessment of biological control agents. The first step in this process was the construction of a conceptual model which identified and summarized existing knowledge in the system. Experiments were conducted to describe functional relationships between the host (WFT) and *A. cucumeris*, spatial patterns and sampling methods for WFT, effect of environmental factors on survival of the host and its predators, and sampling methods for estimating population density of *Orius spp.* in the greenhouse.

SPATIAL ANALYSIS OF PRE-PREY INTERACTION USING A GEOGRAPHIC INFORMATION SYSTEM (GIS). S. H. Gage (Department of Entomology, Michigan State Univ., East Lansing, MI 48823, USA)

The objective of this paper is to bring a landscape ecology perspective to the study of the movement, distribution and abundance of insects in a mixed agricultural/natural landscape. In particular, the study focuses on the analysis of a guild of predaceous Coccinellidae which interact with both the managed and natural elements of the landscape. These predators of herbivores, primarily aphids, traverse the landscape seeking and sampling habitats in which to find acceptable prey and to reproduce.

This paper presents an approach to the analysis of predator populations from a landscape perspective. Predator populations, and their prey, were sampled at regular intervals in different habitats during two growing seasons at two different landscape scales. Temporal and spatial dynamics of predators are assessed at both a farm resolution (local landscape) where agricultural fields and habitats surrounding them were sampled (local landscape) and at a regional level where predators were sampled in agricultural fields within landscapes of different complexity.

The tools of geographic information systems (GIS) and image analysis of remotely sensed data have been brought to bear on characterizing the landscape from the predator's perspective.

SPATIAL DYNAMICS AND THE INTERACTIONS OF A PARASITOID, PATHOGEN AND HOST. David W. Onstad, Center for Economic Entomology, Illinois Natural History Survey and University of Illinois, Urbana, IL 61801, U.S.A.

A complex stochastic model was computed on a CRAY supercomputer to study the dynamics of three species over 25 years in a region of 150 plants. Individual foraging parasitoids were modeled in their maturation, disease-vectoring capability, and movement from plant to plant. Over a hundred life stages of the herbivore were modeled to distinguish insects according to the timing of initial infection and/or initial parasitization. This separation of stages was necessary because of the chronic nature of the microsporidian disease that allowed many herbivores and parasitoids to survive into adulthood. Although the model is based on calibration data for Ostrinia nubilalis (Pyralidae), Nosema pyrausta, and polyembryonic Macrocentrus grandii (Braconidae), some of the scenarios and simulations were purely hypothetical. Under some conditions, the parasitoid co-existed with the other species for 25 years, but in others, extinction occurred. The study focused on parasitoid movement rules, polyembryony, infectivity in the parasitoid population, and vectoring of the pathogen in heterogeneous space.

Genetic Opportunities, Constraints and Risks in Pre-Introductory Screening and Selection of Biological Control Agents. Thomas R. Unruh (USDA-ARS, Yakima, Washington, USA)

Descriptions of genetic structure of insect populations have shown there is no unifying concept for optimizing fitness in introduction programs. Instead, selection must be based on details of the genetic and epigenetic systems under scrutiny and by knowledge of critical biological or ecological traits. Spatial scale of genetic substructuring may be influenced by vagility, sexuality and mating behavior, abundance, habitat affinity and size of the candidate, as well as physical and biological geography of its native range. Knowledge of these characteristics, coupled with understanding of the niche to be filled in the introduction area, may lead to useful judgements on preserving or selecting genetic variation that exists in the native range. Examples of the extent and scale of substructuring of insects populations will be provided. Preintroductory descriptions of genetic structure of natural enemies can help identify host races or host range. Opportunities and risks are inherent in thelytoky and in the sex determination mechanisms of parasitic wasps and mites. How these may be used to optimize collection, importation and release are discussed. Genetic load under different genetic systems of natural enemies and endosymbiosis should be high priority research topics.

STRUCTURE OF PARASITE GUILDS AND ITS RELEVANCE TO INTRODUCTION STRATEGY. L. E. Ehler (Department of Entomology, University of California, Davis, CA 95616 USA)

A parasite guild consists of those species which exploit (parasitize) a given stage of a host species in a particular location. Such guilds can be either natural, restructured, or synthetic (=anthropogenic). Parasite guilds can be analyzed according to the following framework: ecological/evolutionary history, empirical patterns (structure), factors affecting guild structure, ecological impact on the host population, and relationship between structure and impact. It is suggested that guild analysis is of value in deriving introduction strategies for both classical and augmentative biological control. The introduction of Encarsia aurantii into California for control of Melanaspis obscura will be described as a case in point.

PREINTRODUCTION SELECTION OF PARASITOIDS FOR CLASSICAL BIOLOGICAL CONTROL: EVALUATION OF THEIR LIFE HISTORY CHARACTERISTICS. Yoshimi Hirose (Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Preintroduction selection of parasitoids for classical biological control should be based on not only their characteristics but also characteristics of target pests and target areas or environments. Among characteristics of parasitoids, life history characteristics, such as intrinsic rate of natural increase (r), are important in the preintroduction selection because the reproductive potential of parasitoids should be higher than that of their hosts to control. However, the view that the higher r a parasitoid has, the better control agent it becomes, is not supported in classical biological control; extremely high r values of parasitoids result from the fact that their devlopment times are so short that they cannot synchronize with their hosts. Another important life history characteristic of parasitoids in their preintroduction selection is parasitoid's ability to maintain its reproductive capacity during a long period of host shortage. The evidence of these arguments is presented based on the real host-parasitoid systems.

EVALUATION OF SELECTION CRITERIA FOR SEASONAL INOCULATIVE BIOLOGICAL CONTROL.

Oscar Minkenberg (Department of Entomology, University of Arizona, Forbes Bldg., Rm. 410, Tucson, Arizona 85721, U.S.A.)

In order to develop a preintroduction selection procedure for the seasonal inoculative biological control of arthropod pests, four criteria to select parasitoids are evaluated: (1) complete development and offspring quality, (2) generation synchrony, (3) population growth, and (4) searching efficiency. Ways to measure these criteria are described; I further discuss the biological and ecological significance of them. Biological control theory as well as empirical evidence show that these criteria are essential in a preintroduction selection procedure. The first three criteria have shown to be indispensable after evaluating them, after the fact, for two successful hymenopterous parasitoids, *Dacnusa sibirica* and *Diglyphus isaea*. These biological control agents have been used against agromyzid leafminers on tomato since 1984 in two distinct areas, northwestern and southern Europe, respectively. Generation synchrony and population growth partly explain the differences in effectiveness of these parasitoids in temperate Europe versus the Mediterranean.

CLIMATE MATCHING IN BIOLOGICAL CONTROL INTRODUCTIONS. K. R. Hopper (European Biological Control Laboratory, Agricultural Research Service, United States Department of Agriculture, BP 4168, 34092 Montpellier Cedex 5, France)

Often during exploration for natural enemies to introduce for biological control of insect and weed pests efforts are made to match the climate of the collection area to the climate of the introduction area. In this paper, the evidence for the usefulness of such climate matching is reviewed and suggestions are made of further research in this area. Some argue that natural enemies are likely to have more limited distribution than their hosts, of if natural enemies have a wide geographic range they consist of biotypes that are adapted to particular climates. Matches and mismatches of climates have explained some successes and failures of biological control introductions, and computer programs have been developed to assist in climate matching. On the other hand, some argue that introduced natural enemies adapt to their new environment and one should introduce from the widest variety of environments possible to improve the chances of this adaptation. The chief examples of adaptation after introduction involve diapause or temperature tolerance. Even without genetic adaptation, some insects show remarkable flexibility in their ability to survive and reproduce in varied climates. Major research needs include greater understanding about what aspects of climate need to match for success in biological control, about the nature of climatic biotypes, and the level of gene flow between widely separated populations of natural enemies.

PROSPECTIVE MODELLING FOR SELECTION OF AGENTS DURING CLASSICAL BIOLOGICAL CONTROL PROGRAMMES.

Jeff Waage (International Institute of Biological Control, Ascot, Berks, SL5 7TA, UK), H.C.J. Godfray (Imperial College at Silwood Park, Ascot, Berks, SL5 7PY, UK)

The justification for a predictive approach to classical biological control will be discussed. The requirements of practicioners limits the value of, and approaches to, predictive modelling. A number of approaches, based on recent classical control programmes involving insect and pathogen agents, will be discussed. The changing role of modelling in support of biological control will be analyzed, and future directions indicated.

MODELS FOR PREDICTION IN BIOLOGICAL CONTROL. N.D.Barlow & S.L.Goldson (Canterbury Agriculture & Science Centre, Ministry of Agriculture & Fisheries, PO Box 24, Lincoln, New Zealand).

Models offer unrealised potential to assist in pre-introduction selection of control agents, both directly through prospective input to the selection process, and indirectly by aiding in retrospective and concurrent ecological analysis of existing programmes, so as to expand the information base for better-founded theory and future prospective models. In both cases the value of the models may depend on the approach adopted. There are very few examples of genuinely prospective models, particularly involving comparisons of prediction with outcome. Nevertheless, potential opportunities exist in areas such as: climate matching of species/ecotypes based on laboratory studies; aiding in early post-release evaluation so as to mitigate the costs of an inappropriate selection; predicting the stage of a pest that is best attacked and the extent to which density-dependence offsets the likely impact of a control agent; and predicting impacts on non-target organisms given their characteristic population densities relative to those of the target. However, the indirect contribution of modelling is probably more significant. This is because there are still relatively few well-analysed case studies upon which to base useful theory and general conclusions regarding the characteristics of species or ecotypes which predispose them to success. Consequently, the greatest hope for better future preintroduction selection may lie in thorough ecological analyses of past, present and future biological control programmes, and modelling must therefore be seen as an essential adjunct to practical programmes. Both types of application are illustrated using case studies with *Sitona discoideus*, Argentine stem weevil and Vespid wasps in New Zealand.

EXOTIC TERRESTRIAL ARTHROPODS IN THE HAWAIIAN ISLANDS: ORIGINS AND IMPACTS. John W. Beardsley, Dept. Entomology, Univ. of Hawaii, Honolulu, Hawaii 96822, USA.

More than 95% of arthropod pests now present in the Hawaiian Islands were accidentally introduced by man, the majority since Hawaii was colonized by Europeans, ca. 200 years ago. During the past 50 years, new exotic arthropods have become established at the rate of nearly 20 per year, including, on average, 3 new pests of economic significance. Major increases in the speed and volume of overseas air traffic have materially increased the rate of new pest introduction during the past 25 years. Many new potential pests arrive in Hawaii with no effective natural enemies present. In such cases, initial population growth is often exponential, leading to major pest outbreaks (e.g.: Bactrocera dorsalis 1946-48, Nezara viridula 1962-64, Aleurodicus dispersus 1978-80, Heteropsylla cubana 1984-86). Most new pests in Hawaii have originated from North America, Asia and the south Pacific, but during the past 15 years new Neotropical pests have become noticeably more frequent (e.g.: Aleurodicus dispersus, Heteropsylla cubana, Hypothenemus obscurus). Biological control usually is the tactic of first choice to combat new pests in Hawaii. Success has ranged from complete (A. dispersus) or substantial (N. viridula) to partial (B. dorsalis). For some introduced pests (e.g.: Adoretus sinicus) attempts at biological control have been largely ineffective. Unless more effective quarantine measures can be implemented, a continuation of the present high rate of new pest establishment in Hawaii is likely.

MOVEMENT OF INTENTIONALLY INTRODUCED BIOCONTROL AGENTS ONTO UNITENDED BUTTERFLIES HYPOLIMNAS Sp. Donald Nafus (AES, CALS, Univ. of Guam, Mangilao, Guam 96923)

Since 1945 five species of butterflies on Guam have become rare or extinct. On Guam, 27 species of biocontrol agents have been released against Lepidoptera. To see if movement of these agents could be causing problems for nontarget butterflies, from 1987 to 1989 I monitored mortality factors affecting juvenile stages of the nymphalid butterflies Hypolimnas anomala and H.bolina.

Both species were attacked by the same parasitoids and predators. Two biocontrol agents parasitized the nontarget butterflies. One, the egg parasitoid Trichogramma chilonis, was uncommon. The other, Brachymeria lasus, parasitized 19% of the pupae of H.bolina and 2.9% of H. anomala. Parasitoids killed 2.4% of the eggs of H. anomala and 40% of those of H.bolina. Most eggs were parasitized by the native species Telenomus sp. and Ooencyrtus sp. No larval parasites were reared, but larvae of H. anomala suffered heavy mortality from a viral disease, and both species were attacked by exotic, self-introduced predators and ants.

Ants caused heavy mortality, killing all H. bolina eggs and larvae during certain parts of the year. Ants removed 25% of the eggs of H. anomala, 35% of those of H.bolina, at least 17% of the pupae of H. anomala, and 7% of those of H.bolina. All the ants were self-introduced tramp species. The role of exotic ants in the extinction of island species is probably important. Without detailed life history data, the role of ants, deliberately introduced biocontrol agents, and other accidentally introduced general predators is difficult to disentangle.

BIOLOGICAL CONTROL OF THE FRUIT PIERCING MOTH, *OTHREIS FULLONIA* (CLERCK) (LEPIDOPTERA: NOCTUIDAE) IN THE PACIFIC. D.P.A. Sands, W.J.M. Liebregts (CSIRO Division of Entomology, Private Bag No. 3, Indooroopilly, Queensland 4068, Australia)

Adults of the fruit piercing moth *Othreis fullonia* (Clerck) (Lepidoptera: Noctuidae) are serious pests of ripening fruit in most islands of the western Pacific, eastern Australia and parts of South-east Asia. Throughout the range of *O. fullonia* some species of egg parasitoids are abundant and contribute to its biological control but there are few natural enemies of other immature stages likely to be effective. In some countries (e.g. Papua New Guinea) *O. fullonia* is not sufficiently abundant to be a pest, due it is believed, to the activity of natural enemies.

Two hymenopterous egg parasitoids from Papua New Guinea, an *Ooencyrtus* sp. and a *Telenomus* sp. have been established in Fiji and Western Samoa respectively, decreasing the eclosion of eggs of *O. fullonia* and the abundance of moth eggs. The potential contribution of these parasitoids towards biological control of *O. fullonia* in the Pacific and Australia is discussed.

BIOLOGICAL CONTROL OF FRUIT PIERCING MOTHS IN MICRONESIA. R. MUNIAPPAN, G.R.W. Denton, M. Marutani and T.S. Lali (College of Agriculture and Life Sciences, University of Guam Mangilao, Guam 96923, U.S.A.)

Othreis fullonia (Noctuidae) is the primary fruit piercing moth found in Micronesia. Additional primary fruit piercing moths found were Pericyma cruegeri (Noctuidae) in Guam, Rota and Palau, Platyja umminia (Noctuidae) and Ercheia dubia (Noctuidae) in Guam. Larvae of O. fullonia may be feeding on leaves of Erythrina sp in the Marianas and East Caroline Islands. However, they may be feeding on leaves of Menispermaceae plants in the East Caroline Islands. Larvae of P. cruegeri feed on leaves of Delonix regia and Peltophorum ferrugineum. Larval hosts of E. dubia and P. umminia are yet to be determined. Telenomus sp., Trichogramma sp. and Ooencyrtus sp. parasitize eggs of O. fullonia. Eggs of P. cruegeri are parasitized by Trichogramma sp., larvae by Exorista civiloides and pupae by Brachymeria sp.

BIOLOGICAL CONTROL OF FLOATING WEEDS: HISTORY AND STATUS. Peter M. Room (CSIRO Division of Entomology, PB No 3, Indooroopilly, Q 4068, Australia)

Biological control has solved many major problems caused by floating weeds and insects have been the best control agents. Most of the these weeds originated in South America and caused problems when they were introduced into the tropics and subtropics of other continents. The search for control agents started in the 1960's and now most infestations of alligator weed, salvinia and water lettuce, and many of water hyacinth, have been brought under biological control. There has not been a single case of an agent becoming a pest following control. Significant infestations of some floating weeds remain in Africa, Madagascar, the Philippines and Indonesia due to administrative rather than scientific difficulties. Several other floating plants, notably members of the fern genus Salvinia in South America and Asia, are likely to become important weeds if they become established outside their native continents. If quarantine measures fail to prevent this, prospects for their biological control are good. Reasons include past experience, extensive vegetative propagation/genetic uniformity in these plants, and packing together of individul free-floating plants by the wind which maximises the searching efficiency of control agents.

RESURGENCE OF A NATIVE MOTH COMMUNITY FOLLOWING BIOLOGICAL CONTROL OF AN INTRODUCED PEST MOTH. Ilse Schreiner, Donald Nafus (AES, CALS, Univ. of Guam, Mangilao, Guam 96923)

Following biological control of an introduced pest, the mango shoot caterpillar Penicillaria jocosatrix Guenée (Lepidoptera: Noctuidae), populations of four other species of Lepidoptera using mango on Guam increased. These moths included three species of Geometridae, the widespread Anisodes illepidaria Guenée, Thalassodes sp., and Chloroclystis sp., and the noctuid Nanaguna breviuscula Walker. These moths are native to Guam and two species may be endemic. Thalassodes sp., Chloroclystis sp. and N. breviuscula were most commonly found on mango inflorescences, and probably became more abundant as a result of an increase in mango flowers. A. illepidaria caterpillars, which eat both leaves and flowers, increased by an order of magnitude. Comparison of its larval biology with the mango shoot caterpillar showed that it preferred an older age class of new leaves. The two introduced biological control agents acted as keystone predators, preventing the mango shoot caterpillar from preempting mango as a resource for other Lepidoptera species.

HISTORY OF BIOLOGICAL CONTROL IN AMERICAN SAMOA. Pemerika L. Tauili'ili, Agnes M. Vargo (American Samoa Community College, Pago Pago, American Samoa, 96799)

Biological control has been the primary method of managing pest problems in American samoa from 1954 to the present. Projects from 1954 to 1975 included the introduction of the marine toad, *Bufus* sp., for mosquito and centipede control; *Toxorynchetes* sp. for mosquito control; the praying mantis for control of the walking stick, *Graffea crovani; Baculovirus orcytes* for the coconut rhinoceros beetle, *Orcytes rhinoceros; Tetrasticus brontispae* for the coconut hispid beetle, *Brontispa longissima;* and *Liothrips urichi* for control of the weed Koster's Curse, *Clidemia hirta.* A major project was the control of the Giant African snail, *Achatina fullica,* by the predator snails *Gonaxis kibweziensis and Euglandina rosea.* More recent introductions include the predatory beetles *Nephaspis amnicolor, N. bicolor,* and *Delphastus pusillus,* and the parasitic wasp, *Encarsia haitiensis* for the spiralling whitefly, *Aleurodicus dispersus.* Introductions to control the coconut scale insect, *Aleurodicus dispersus,* include the predatory beetles *Pseudoseymnus anomolus, Rhyzobius lophante, Telsimia nitida, Chilochorus nigritis,* and a parasitic wasp, *Aphytis* sp. The fungus *Metarhizium anisopliae* is used to control *B. longissima.* While past introductions generally focused on the actual release of an organism to control the pest, current projects focus on pre- and post-release surveys and evaluation of release efforts.

SUCCESS OF NATIVE NATURAL ENEMIES IN CONTROLLING INTRODUCED PESTS IN AMERICAN SAMOA. Agnes M.Vargo, **Sipaia Fatuese, Lloyd Ali, Siafoi Fa'aumu, Valentine Sworts,** and **Kolose Fruen** (American Samoa Community College, Pago Pago, American Samoa, 96799, USA)

Several complexes of insect predators and parasites, native to American Samoa, have been effective in controlling a number of introduced pests. In experiments documenting the interaction between longterm taro pests and their biological controls, populations of the following insects were quickly reduced and held in check by natural enemies: *Spodoptera litura, Aphis gossypi, Hippotion celerio,* and *Tarophagus proserpina.* A study documenting cucurbit pests and their naturally-occurring biological controls in American Samoa showed *Thrips palmi* and *Epilachna cucurbitae* to be devastating pests in 1985 and 1986. Observations of cucurbit pests in 1990 report only occasional outbreaks of these pests. Several predators of the diamondback moth, *Plutella xylostella,* a pest of cabbages in American Samoa, have virtally disappeared after causing devastating losses in 1988 and 1989. The fruit-piercing moth, *Othreis futlonia,* is also under control by a number of biological control. The observed ability of native natural enemies to control introduced pests in American Samoa emphasizes the importance of the "Conservation of Natural Enemies" aspect of biological control. A program to educate farmers and the public about biological control effectiveness is underway on the island in order to assist growers in making an informed decision before resorting to pesticide alternatives.

HISTORY OF BIOLOGICAL CONTROL IN THE FREELY ASSOCIATED STATES OF MICRONESIA. Anita R. Suta and Nelson M. Esquerra (College of Micronesia Land Grant Programs, P. O. Box 1179, Kolonia, Pohnpei, FSM 96941).

There had been many introductions of parasites and predators to control pests in the past, but in majority of cases their impact on the population of the pests to which they had been introduced had not been fully assessed.

In recent years, the releases of biological control agents were instrumental in reducing pest abundance as in the case of the coconut scale on Kapingamarangi, Pohnpei, FSM and Majuro, Republic of the Marshall Islands: spiraling whitefly on Nukuoro Island and main island of Pohnpei: orange spiny whitefly on Pohnpei, Kosrae, chuuk and Yap, FSM; green stink bug, bean leafminer, Siam weed and fluted scale on Pohnpei, FSM.

BIOLOGICAL CONTROL OF THE PHILIPPINE LADY BEETLE, EPILACHNA PHILIPPINENSIS DIEKE (COLEOPTERA: COCCINELLIDAE), ON SOLANACEOUS PLANTS BY INTRODUCING THE PARASITOID, PEDIOBIUS FOVEOLATUS CRAWFORD (HYMENOTPERA: EULOPHIDAE), ON SAIPAN. Chao-Hon Chiu, Aubrey Moore (Northern Marianas College, Saipan MP96950, U.S.A.)

The Philippine lady beetle became a serious pest of solanaceous crops on Saipan after its accidental introduction in 1948. In 1985, 4620 P. foveolatus adults were reared from E. philippinensis pupae which had been parasitised as larvae by a laboratory population in Delaware, U. S. A. These were released into two heavily infested fields, both mixed plantings of eggplant and tomato. In a 1989 island-wide survey , P. foveolatus were reared from 80% of E. philippinensis larvae collected. Prior to release, E. philippinensis was typically controled using biweekly insecticide applications. Chemical control is now required only occasionally in response to outbreaks. Success of this program may be due to abundance of solanaceous weeds, Physalis spp., providing an untreated refuge for parasitoid production.

BIOLOGICAL CONTROL OF THE GREEN STINKBUG, NEZARA VIRIDULA (LINN.) IN THE FEDERATED STATES OF MICRONESIA. Nelson M. Esquerra, William William and Justino R. Smith (College of Micronesia Land Grant Programs, P. O. Box 1179, Kolonia, Pohnpei FSM 96941.

Nezara viridula (Linn.) (Hemiptera: Pentatomidae) has always been considered a major insect pest of vegetables on Pohnpei, Chuuk and Yap States of the Federated States of Micronesia. The egg parasitoid, Trissolcus basalis that came from Hawaii was released on Kolonia, Nett and Madolenimw, Pohnpei. The parasitoids could be recovered readily on stink-bug eggs 3 and 6 months from release. As a result of this introduction, the stinkbug population became so low that it could hardly be observed feeding on any vegetable plantings on the island.

BIOLOGICAL CONTROL OF THE *LIRIOMYZA* LEAFMINERS IN THE PACIFIC BASIN. Marshall W. Johnson (Department of Entomology, University of Hawaii at Manoa, Honolulu, Hawaii 96822, U.S.A.)

Since 1980, the importance of agromyzid leafminers in the genus *Liriomyza* in the Pacific Basin has increased significantly. This change in pest status has been associated with the introduction of *Liriomyza trifolii* (Burgess) and *Liriomyza sativae* Blanchard to many Pacific islands ranging from Hawaii to Guam above the equator to New Caledonia and French Polynesia below the equator. These species are predominanly pests on vegetable and ornamental crops throughout these localities. On most vegetable crops, the leafminers only effect the non-marketable leafy portions of the plant, reducing the photosynthetic capabilities of the plants. Relatively high populations can be tolerated without economically significant damage to a crop. Given this, the potential to control *Liriomyza* infestations through indigenous and introduced natural enemies is high.

Numerous parasitoid species have been introduced for *Liriomyza* control in Hawaii. These include the effective species *Chrysocharis oscinidis, Chrysonotomyia punctiventris, Ganaspidum utilis,* and *Halticoptera circulus.* An indigenous species, *Diglyphus begini,* also occurs in Hawaii. Those providing high levels of control in Hawaii have been introduced into Guam, Pohnpei and Tonga. Research in Hawaii indicates that a mutiple natural enemy species introduction approach is needed for *Liriomyza* control over numerous crop systems. Parasitoid effectiveness and presence can vary significantly among crops with common natural enemy species varying from 6 to 12 species over several crops. One of the most signifcant introduced species to Hawaii is *Ganaspidium utilis* which quickly made an impact on leafminer densities, successfully competing with previously established parasitoids.

Recent research in Hawaii has resulted in the discovery of highly pesticide resistant strains of *Diglyphus begini.* Laboratory selection has increased pesticide resistance in *Ganaspidium utilis.* Work is currently underway to evaluate the possibility of introducing these strains to other localities where the leafminers are a problem. Of additional significance is the research on developing entomopathogenic neamatodes for *Liriomyza* management.

MANAGEMENT OF NONPERSISTENTLY TRANSMITTED VIRUSES USING CLASSICAL CROSS PROTECTION AND APHID NATURAL ENEMIES. Diane E. Ullman (Department of Entomology, University of Hawaii, 3050 Maile Way, Rm 310, Honolulu, HI 96822), John J. Cho (Department of Plant Pathology, Maui Branch Research Station, P.O. Box 269, Kula, Hawaii 96790), Marshall W. Johnson and Bruce E. Tabashnik (same as first author).

Epidemics of aphid transmitted viruses such as, zucchini yellow mosaic virus (ZYMV), papaya ringspot virus-watermelon isolate (PRSV-W), watermelon mosaic virus-2 (WMV-2) and cucumber mosaic virus (CMV), severely limit commercial production of cucurbit crops in Hawaii and elsewhere in the Pacific Basin. Efforts to limit epidemics of ZYMV and PRSV-W in Hawaii using classical cross protection with mild virus strains have met considerable success, dramatically increasing zucchini harvests on the Hawaiian island of Maui. The benefits, potential risks and appropriate uses of classical and bioengineered cross protection in managing insect transmitted virus epidemics will be discussed.

The melon aphid, *Aphis gossypii* is ubiquitous throughout the Pacific Basin on cucurbit crops and is the only aphid vector species colonizing cucurbits. This aphid species is frequently a target of control efforts as its feeding may cause direct damage and it is a vector of the cucurbit virus complex mentioned above. In the absence of pesticides, natural enemies have been shown to effectively manage aphid populations below nominal density treatment levels in watermelon crops in the Hawaiian islands. Potential techniques for enhancing the use of natural enemies in managing aphid populations in cucurbits and the impact of natural enemies on aphid activity and virus epidemiology will be discussed.

AN INTEGRATED APPROACH TO ADORETUS CONTROL IN HAWAII AND AMERICAN SAMOA. L.H. Tsutsumi, S.C. Furutani, M. Nagao (University of Hawaii, Hilo, Hawaii, U.S.A.), V. Swarts, K. Marschal, and A. Vargo (American Samoa Community College, Pago Pago, American Samoa)

The Chinese rose beetle, Adoretus sinicus Burmeister Coleoptera: Scarabaeidae), has been identified as a pest with a large host range in Hawaii. Damage is caused by the adults and is characterized by distinct interveinal feeding on host plant leaves. Similarly, the rose beetle, Adoretus versutus Harold, effects significant feeding damage on a wide range of agriculturally important plants in American Samoa.

Studies are presently being conducted in Hawaii and American Samoa to develop potential control strategies for these rose beetles. The studies, which are targeted towards both the larval and adult stages, include: 1) screening of fungi, nematodes, and bacteria for use on larvae and adults, 2) development of traps and synthetic lures for adults, and 3) feasibility of trap crops. The current status of these studies will be presented.

Biological Control of Banana Skipper, *Erionota thrax* (L.) (Lepidoptera: Hesperiidae) in Papua New Guinea. D.P.A. Sands and F. Dori.
(CSIRO Division of Entomology, Private Bag No. 3, Indooroopilly, Queensland 4068, Australia and Laloki Research Station, Department of Agriculture & Livestock, PO Box 417, Konedobu, Papua New Guinea).

A specimen of banana skipper, *Erionota thrax* (L.), a pest of Southeast Asian origin, was collected in northwestern Papua New Guinea (PNG) in 1983. Between 1986–1989 it spread and defoliated banana plants throughout mainland PNG and in January 1991 the pest was observed in West New Britain. Surveys showed that the egg parasitoids, *Ooencyrtus erionotae* Ferriere, *Ooencyrtus* sp. and *Anastatus* sp. were already established in eggs of *E. thrax* but only *O. erionotae* was having a significant impact on abundance of its host.

The larval parasitoid, *Cotesia (= Apanteles) erionotae* Wilkinson (Braconidae), was introduced from Guam into a quarantine facility in Papua New Guinea (PNG) in 1989 to assess its suitability as a biological control agent of *E. thrax*. Host specificity tests were conducted by exposing larvae of four species of Lepidoptera (3 Papilionidae, 1 Hesperiidae) to adults of *C. erionotae*. The behavioural response of gravid female parasitoids and failure of parasitoids to develop in the larvae tested, indicated that the parasitoid would not attack these species of Lepidoptera if *C. erionotae* was released in PNG as a biological control agent for *E. thrax*.

C. erionotae was released in five Provinces of PNG between March and October 1990 and in New Britain in 1991. The parasitoid was first recovered from the field in May 1990 and it has since established in the Central and Morobe Provinces, attacking up to 67% of larvae of *E. thrax*.

Prospects for biological control of *E. thrax* in PNG by *C. erionotae* appear to be promising.

INTRODUCTION: PROPAGATION AND RELEASE OF PARASITOIDS AND PREDATORS TO CONTROL ARTHROPOD PESTS. EDGAR G. KING (U.S. DEP'T. OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE, SUBTROPICAL AGRICULTURAL RESEARCH LABORATORY, WESLACO, TEXAS 78596, U.S.A.)

Propagation and release (augmentation) of predators and parasitoids is the most direct means of rapidly increasing their numbers. This augmentation technology is being widety used in China and the former Soviet Republics, Mexico, some European countries, particularly The Netherlands, and to a lesser extent in the U.S.A. and Canada. This Symposium presents examples of successful biological control by augmentation in forest, field crop, vegetable, citrus, poultry houses feedlot, and stored product environments. Technologies and knowledge bases undergirding the augmentation approach to pest control, including "Facilities and Automation for the Mass Production of Insect Predators and Parasitoids,""Nutrition, Artificial Diets, and In Vitro Rearing of Predators and Parasitoids," "Managing the Behavior of Predators and Parasitoids in Mass Production and Augmentation Systems", "Quantitative Population Ecology and Efficacy of Augmenting Predators and Parasitoids", and "Economic and Operational (Socioeconomic) Feasibility, Impediments and Opportunities" are treated separately in the Symposium. All presenters will be asked to identify critical research and development needs for expanding and further commercializing the augmentation technology.

USE OF CHRYSOPIDS IN AUGMENTATIVE RELEASE PROGRAMS FOR CONTROL OF ARTHROPOD PESTS. Ren Wang (Biological Control Laboratory Chinese Academy of Agricultural Sciences, Beijing 100081, China). Donald A. Nordlünd (USDA, ARS, SPA, SARL, Biological Control of Pests Research Unit, Weslaco, Texas 78596, USA)

The family Chrysopidae contains several important predaceous biological control agents that are used in augmentation programs. These predators attack a variety of soft bodied insects including, aphids, mealybugs, whiteflies, mites, and lepidopterous eggs and small larvae. They are also found on numerous agricultural crops. Because they are generalists, predaceous chrysopids may be used in a wide variety of agricultural situations. This is of significant benefit to the commercial insectary. The use of chrysopids in augmentations programs will be reviewed and potential uses will be discussed. Impediments to the wide spread use of these important biological control agents will also be discussed.

CONTROL OF LEPIDOPTEROUS PESTS BY AUGMENTATIVE RELEASES OF *TRICHOGRAMMA* SPP. IN THE FOREST ENVIRONMENT. Sandy M. Smith (Faculty of Forestry, University of Toronto, Toronto, Ontario, Canada, M5S 3B3).

Worldwide, few augmentative releases of *Trichogramma* have been made in the forest environment. One of the most intensive studies in this area was conducted in Canada during the 1980's against a major conifer defoliating species, the spruce budworm, *Choristoneura fumiferana* (Lep.: Tortricidae). The development of this control strategy in forestry has addressed aspects similar to other augmentative studies such as the timing, frequency and rate of parasitoid release, the impact on pest populations and damage, parasitoid collection, dispersal and quality, and the effect of weather parameters and predation on released material. Other aspects examined have been very specific to forest situations in Canada including temperatures of flight, threshold, complexity of the searching environment, and application technology. Research is now focused on applying the technique to suppress lepidopterous forest pests such as the spruce budmoth, *Zeiraphera canadensis*, a cryptic shoot feeder with no current method of control, and the forest tent caterpillar, *Malacosoma disstria*, a deciduous defoliator found cyclically at outbreak levels throughout North America.

The present paper will discuss those factors which must be considered when developing a strategy for inundative release under forest conditions and some of the challenges facing the implementation of this approach. Our system developed in forestry with *T. minutum* will identify the effects of different forests on levels of parasitism and then contrast our approach with that using other *Trichogramma* spp. in agriculture.

CONTROL OF MUSCOID FLIES IN POULTRY HOUSES AND FEEDLOTS. Philip B. Morgan, Donald R. Barnard (Medical and Veterinary Entomology Research Laboratory, USDA, ARS, P.O. Box 14565, Gainesville, FL 32604, USA)

Augmentative releases of Spalangia endius Walker in combination with manure management effectively controlled populations of Musca domestica L. and Stomoxys calcitrans (L.) at poultry, swine, dairy, and beef installations. Monitoring the third instar larval population provided a safe and reliable method for evaluating the effectiveness of the parasite releases.

UTILIZATION OF *TRICHOGRAMMA* SP . FOR THE CONTROL OF INSECT PEST OF RICE AND SUGARCANE IN CHINA . Kai-jia Dai , Ai-hua Cao (Department of Biology , Wuhan University , Wuhan 430072 , China)

Utilization of *Trichogramma* for the control of insect pests of rice and sugarcane in more than ten cities and provinces in the south of China has been carried out and the good effects have been achieved . The kinds of controlled insect pests include rice stem borers , *Chilo suppressalis* , *Scirpophaga incertulas* , rice leaf rollers , *Cnaphalocrocis medinalis Parnara guttata* , and sugarcane borers , *Chilo infuscatellus* , *Chilo sacchariphagus indicus* , *Argyroploce schistaceane* . The species of utilized *Trichogramma* include *T . japonicum* , *T . chilonis* , *T . australicum* , T . dendrolimi , T . *nubilale* . In general , the parasitism rates of *Trichogramma* against mass-eggs or eggs of *Cnaphalocrocis medinalis* , *Parnara guttata* , *Chilo suppressalis* in different vareties of rice and *Chilo sacchariphagus indicus* , *Argyroploce schistaceana* in sugarcanes are over 80% . The parasitism rates of *Trichogramma* against other insect pest eggs are 50-80% . The rolled leaves rates , dead-heart rates , dead-sheath rates , white head rates of rice and the dead-hearts rates of shoods , dead-tops rates , bored joints rates of sugarcanes apparently decreased . *T . japonicum* and *T . chilonis* are superior kinds for the control of insect pests mentioned above in rice and sugarcane respectively .

CONTROL OF STORED PRODUCT ARTHROPOD PESTS BY AUGMENTATIVE RELEASES OF PREDATORS AND PARASITOIDS. J. H. Brower and R. T. Arbogast (Agricultural Research Service, USDA, Stored-Product Insects Research and Development Laboratory, Savannah, GA, 31403, USA)

Application of predator and parasitoid releases for the control of pests in stored agricultural commodities is an old idea that only recently has been tested on a practical scale. Advantages of this technology are its complete safety, lack of chemical residues and absence of host resistance. This technique is sophisticated and requires knowledge of pest species composition and abundance, and periodic releases of beneficials. Larger scale tests include several tests using Trichogramma spp. to control moths of stored commodities. The most successful used Bracon hebetor as a larval parasitoid combined with T. pretiosum as an egg parasitoid and gave control up to 98% on inshell peanuts. A test on inshell peanuts in a warehouse used B. hebetor and the predatory bug, Xylocoris flavipes and gave moth population reductions of up to 83% compared to chemically treated peanuts. Using beneficials to control residual populations in empty grain storage bins containing residues have been very successful. Tests in bins of stored rice and milo(sorghum) produced more variable results. Target species for which specific parasitoids were released showed greatly decreased population growth rates in comparison to untreated populations. In some tests this reduction has been as good as the control achieved by chemical treatments. Developmental improvements in mass rearing and release techniques should soon provide for a cost competitive alternative to chemical pest control in some storage situations.

FACILITIES AND AUTOMATION FOR THE MASS PRODUCTION OF INSECT PREDATORS AND PARASITOIDS. Donald A. Nordlund (USDA, ARS, SPA, SARL Biological Control of Pests Research Unit, Weslaco, Texas 78596, USA), Sh. M. Greenberg (All-Union Institute of Biological Methods in Plant Protection, Kishinev, Moldavia, USSR)

The wide spread use of inoculative and inundative releases of predators and parasitoids for biological control of insect pests is constrained by our limited ability to efficiently and economically produce the very large numbers of high quality insects that are required. The ability to produce high numbers of quality entomophages is dependent on our having well designed production facilities utilizing automated and mechanized rearing systems. Design of such facilities and systems must include consideration of diet, sanitation, environmental, quality control, storage, distribution, and management requirements. Existing facilities and systems will be reviewed and systems being developed will be discussed.

NUTRITION, ARTIFICIAL DIETS, AND IN VITRO REARING OF PARASITOIDS AND PREDATORS. Simon GRENIER (Lab. Biologie Appliqué - 406, INSA-INRA, 69621 Villeurbanne, France), Patrick GREANY (Insect Attractants, Behavior & Basic Biology Research Lab., USDA-ARS, Gainesville, FL 32604, USA), Allen COHEN (Western Cotton Insect Research Lab., USDA-ARS, Phoenix, AZ 85040, USA).

The basic qualitative nutritional requirements of parasitoids and predators are not greatly different than those of other insects. A good balance between proteins, lipids, carbohydrates, minerals, sterols, vitamins and especially amino acids is required. Diet osmolarity is an important factor for many endoparasitoids. The components used for the artificial medium, its presentation, and the containers used must be well suited to the physiological requirements of each species. It is desirable if the medium also induces egg laying. The diet must reflect the special needs of endoparasitoids, ectoparasitoids, oophagous species and predators. Larval endoparasitoids, which are the most physiologically integrated with their hosts, have proved to be the most difficult to rear in vitro. The probability of success in development also depends on the kind of medium; completely defined media are more difficult to produce as compared with media comprised partially of insect derivatives, usually hemolymph or a hemolymph component. A culture of Geocoris punctipes has been kept in continuous culture for 90+ generations using a diet comprised of beef liver, fatty ground beef and a sucrose solution (modeled to reflect the composition of Heliothis virescens eggs). This technology now is being scaled up to allow mass production of Geocoris for control of various field crop pests. Similar success is expected in the near future for Trichogramma spp., and for larval parasites thereafter.

Managing the Behavior of Parasitoids in Mass Production and Augmentation Systems

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The mass production of insects requires some knowledge of the behavior of the insect in question. However, insects can often be effectively reared based on a certain minimal amount of behavioral information. Additional behavioral information may be required to develop an effective continuous culture. Further, the behaviors required to rear may be very different from those required by the organism to reproduce in nature. For biological control using laboratory or mass produced parasitoids; all these behaviors are essential.

The behavior of parasitoids important to their mass cultures will be reviewed. Some behavioral assays to evaluate the quality of the mass produced beneficials will be suggested. Also, the behaviors important to augmentation will be discussed along with the possible influence that *in vitro* production and mass culture may have on their behavior.

ROLE OF GENETIC IMPROVEMENT AND THE SELECTION AND MAINTENANCE OF BIOTYPES IN MASS PROPAGATION AND AUGMENTATION PROGRAMS

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The selection and maintenance of biotypes is an integral component of total quality control in insect mass production, a system incorporating both biological evaluation and program management. The colonized strain must be monitored for competitiveness and protected from genetic deterioration by enforcing production control (monitoring all rearing operations in terms of personnel, materials equipment, schedules, environments, etc.), enforcing process control (sampling immature insect stages to predict quality and determine sources of variability), establishing product quality control (determining performance at the facility and at critical points to field application), measuring competitiveness, and providing feedback to optimize production and field delivery. The entire total quality control system includes eight generic elements: Management, Research, Methods Development, Material, Production, Utilization, Personnel and Quality Control. This comprehensive approach to quality control of biological systems is essential to improve biological control-based insect control technologies.

ECONOMIC AND OPERATIONAL FEASIBILITY: IMPEDIMENTS AND OPPORTUNITIES. Sinthya Penn, Fernando Agudelo (Beneficial Insectary, 14751 Oak Run Rd., Oak Run CA 96069 U.S.A.)

Augmentation of parasitoids and predators to control arthropod pests is receiving considerable commercial attention. This attention will demonstrate economic possibilities, increase opportunities and, eventually, reduce impediments; unless inappropriate and unnecessary regulations are enacted.

Economic and operational feasibility currently varies greatly by region, crop & pest complex, other controls available, education, general attitude, and amount and type of government support.

Impediments include a lack of mechanization at all levels while maintaining product integrity, lack of standardized quality control protocols, and a shortage of rapid and accurate systems of identification.

Opportunities exist and more will become available through cooperation with governments, universities, and private companies.

TEMPERATURE AND HOST FACTORS, INDUCING THE DIAPAUSE OF TRICHOGRAMMA SPP. Liying Li & Difang Zhu (Guangdong Entomological Institute, 105 Xingang West Road, Guangzhou 510260, China), V.A. Shliactich & A.M.Greenberg (All-Union Institute for Biological Plant Protection, 58 Prospect Mira, Kishinev 277072, Moldova, USSR)

The stable diapause of Trichogramma is the main condition for its long-term storage, a very important procedure in mass production and utilization of Trichogramma for biological control of agricultural and forestrial insect pests. Our experiments showed that the higher percentage (50-100%)of prepupal diapause of Trichogramma spp. occurred when they were treated for 30 days at the end of larval stage with the following regime:

For T. japonicum: Under 8, 10, 12℃ in the eggs of Sitotroga cerealella & Corcyra cephalonica. But the diapause was stable only in the eggs of S. cerealella under 8℃ and 10℃.

For T. ostriniae: Under 8℃ in the eggs of S. cerealella & C. cephalonica and under 10℃ in the eggs of C. cephalonica. But the stable diapause happened only in the eggs of S. cerealella under 8 ℃.

For T. dendrolimi: Under 8,10℃ in the eggs of S. cerealella, C. cephalonica & Antheraea pernyi. But only in the eggs of S. cerealella under 8,10℃ the diapause was stable.

For T. confusum: Under 8℃ in the eggs of C. cephalonica & Antheraea pernyi or under 10℃ in the eggs of A. pernyi. But non-stable diapause was obtained.

EFFECT OF VARIED TEMPERATURE ON THE INDUCTION OF DIAPAUSE IN TRICHOGRAMMA OSTRINIAE PANG ET CHEN. Hong-yin Chen (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

The role of the temperature to induce Trichogramma ostriniae into diapause was preliminary investigated in the nature of Beijing Area. The emergence time and rate were affected by the proportion of diapause in the following spring. In climate cases the constant temperature of 9℃, 11℃ , 13℃, 15℃, 18℃ and 5 different photoperiod combinations could not induce the present generation of the wasp into diapause. The parental generation treated with 15℃ and 12 hours photoperiod caused more its descendent to enter diapause more than that teated with 15℃ and 20 hours photoperiod. A method of simulating the natural daily prewinter temperature change in Beijng Area was adopted to induce the diapause of Trichogramma ostriniae in a climate chamber. The results showed a diapause rate of 43.9% occurred after 30 days development. When the shape of the temperature wave was changed and the range of the tempertature was expanded the rate of diapause could reach 77.9%. The diapause of the wasp might be broken automatically under the temperature condition of 0℃ , 3℃, and 5℃, for 30 to 70 days. It could not be broken at 22℃ and 26℃ unless being treated with 0℃ or 5℃.

STIMULATION OF THE OVIPOSITION BY THE OOPHAGOUS PARASITOID *TRICHOGRAMMA BRASSICAE* (HYMENOPTERA) IN ARTIFICIAL HOST EGG PLATES. Simon GRENIER, Valérie VEITH (Laboratoire de Biologie Appliquée, INSA-INRA, 69621 Villeurbanne France), Michel RENOU (Laboratoire des Médiateurs Chimiques, Brouessy, 78470 St Rémy-les-Chevreuse, France)

The development of some *Trichogramma* species is possible in artificial conditions, but the number of eggs laid by females is often reduced compared to those laid in natural host eggs. Cupules were made in a plastic film and filled with artificial medium containing hemolymph from *Mamestra brassicae* pupae. One plate contained 54 cupules. The cupules were surface treated with pure solvent, *Ostrinia nubilalis* scale extract or a mixture of compounds previously identified in *O. nubilalis* egg masses, in order to improve the oviposition performance of *Trichogramma brassicae* (non treated cupules were used as control).

The number of eggs obtained was much higher in cupules treated with extract or mixture (10-15 times) than in control. The number of eggs obtained was also higher in cupules treated with the solvent alone (3-6 times) than in control. Modifications of the structure of the membrane surface can explain the stimulation of the oviposition observed with the solvent. Scale extract increased the stimulation as well as a mixture of saturated hydrocarbons. On the same plate, the number of eggs obtained was much higher in treated cupules than in control ones: the extract or the mixture acts as a contact kairomone. In biological control programs, such treatments could be used to increase the yield of *Trichogramma* rearing in artificial conditions.

NUMBER ALLOCATION AND SEX ALLOCATION IN PROGENY OF TRICHOGRAMMA. Ming-fang Guo, Jing-ye Zhang, Li-ying Li (Guangdong Entomological institute, Guangzhou, 510260, China)

In this paper, observation and comparison of ovipositional behaviour of Trichogramma spp. on different factitious host eggs and study on number allocation and sex allocation in progeny of Trichogramma have been described. The experimental results showed that Trichogrammatid females were capable of controlling their progeny allocation. Either on different host-eggs or on the same kind of host-eggs in different distribution, the females had adaptive strategy to allocate their progeny both in number and in sex. It was observed that the sex ratio of the eggs laid by Trichogrammatid females could be accurately determined.

STUDIES ON THE REPRODUCTIVE STRATEGY OF TRICHOGRAMMA DENDROLIMI MATSUMURA. Yu-rong He, Li-hua Lu, Cheng-lun Wang (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Gongzhuling 136100, China)

The reproductive strategy of Trichogramma dendrolimi M. was studied in the laboratory during the March of 1987 to the April of 1988. The results were as follows:

1. By observing female wasps oviposition behaviors on various host eggs, it showed that wasps could estimate the host egg volume by climbing on the egg and lay more progeny and less sex ratio (proportion male) in larger host than those in smaller ones.

2. By examing the effect of different combination of males and females per egg of perny silkworm (Antherene pernyi) on the size, longevity and fecundity per female of progeny, it showed that the size of progeny was maximum in the combination of 10-20 males and 20-30 females, the fecundity per female was maximum in the combination of 1-5 males and 50-60 females, and the total progeny fecundity was maximum in the combination of 6-10 males and 80-100 females.

3. The relation between the fecundity per female (Y) and the wasp number per host egg(X) was $\log Y=0.5436+8.695X-2.518\ (\log X)^2$. A domed shaped fitness function showed Allee Effect exists. The total progeny fecundity (W) could be forecasted with the wasp number per host egg and the number of females per egg (N) . The equation was

$$W=N(3.67^{-6X}\ 8.695-2.518\log X).$$

FERTILITY AND LIFE TABLE STUDY FOR TRICHOGRAMMA SP. -NR. MWANZAI Qing-guang Lu (Biological Contrlo Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

This study conducted in the ICIPE is the first report on fertility and life table of a native wasp, Trichogramma sp. nr. mwanzai Schulten &Feijien, a predominant egg parasitoid of Chilo partellus in Kenya and Africa. Under five constant temperatures of 35, 30, 25, 20 and 15℃ the intrinsic rate of natural increase r_m of the wasp has the value of 0. 4603, 0.4075. 0.3337, 0.1101 and 0. Net reproductive rate R. and finite rate of increase were also determined. The native wasp has relatively high biotic potencial by comparison with the r_m value of some species of Trichogramma used widely suggesting that T. sp. nr. mwanzai might be the most promising agent for biological control of C. partellus in this region.

A STUDY OF HEIGHT AND HABITAT TYPE ON EGG PARASITISM OF COCOA PODBORER BY Trichogrammatoidea bactrae fumata Nagaraja. GUAN_tick LIM (TFE TEH Sendirian Berhad, 14-16 Jalan Hang Lekiu, 50100, Kuala Lumpur, Malaysia).

A study of height and habitat type on egg parasitism of cocoa podborer Conopomorpha cramerella (Snellen) (Lep: Gracillariidae) by T. bactrae fumata was conducted in a cocoa estate under Gliricidia maculata shade tree where no chemical was applied.

The relationship between the level of tree height and number of eggs parasitized by the parasitoids was significantly correlated (P>0.01). The parasitoids preferred to attack the cocoa podborer eggs on pods loading at 201-250 cm height with 26.3±7.1% parasitism. The number of parasitized eggs was positively correlated with the number of cocoa podborer eggs and highly significant (r= 0.91; P> 0.01). Percentage parasitism on pods from branches was significantly greater than that on trunk (P>0.05). Mean parasitism per pod and per tree were 36.3± 5.4% and 33.0± 5.3% respectively.

RESPONSES TO HOST PATCH SIZE BY *TRICHOGRAMMATOIDEA CRYPTOPHLEBIAE* IN CITRUS, AND ITS COMMERCIAL IMPLICATIONS. Philip J. Newton (CIBA–GEIGY LTD., Plant Protection Division, Natural and Biological Products, R-1093.4.45, CH-4002 Basel, Switzerland).

To examine the nature of the functional response of *Trichogrammatoidea cryptophlebiae* Nagaraja to *Cryptophlebia leucotreta* (Meyrick) eggs, different patch sizes of eggs were created on fruits which were then suspended on trees in a citrus orchard. Direct observations were made of *T. cryptophlebiae* visiting these patches. Rate of parasitism, progeny and sex allocation were recorded later.

T. cryptophlebiae displayed an aggregative response to host-patch size but parasitoids did not fully exploit all the egg patches they discovered and percent parasitism remained fairly constant overall. As patch size increased, parasitoids apparently did not attempt to increase rate of parasitism by distributing progeny individually in more host eggs, but rather maintained a fairly constant overall number of progeny per egg. Male:female sex ratio was also fairly constant. When singletons were laid, sex ratio was in favour of females in small patches. The proportion of males increased with increasing patch size. When more than one progeny was laid in each host-egg, sex ratio was maintained in favour of females.

This parasitoid appears to maintain an equilibrium with its host by allocating progeny and their sex amongst the available host. This means that the commercial impact of inundative releases is critically determined by the distribution of host-eggs on fruits. It may be possible to overcome this tendency by increasing volume of release. An alternative would be to alter sex allocation, fecundity, and searching characteristics by selective rearing programmes prior to release. Another approach may be to search for new parasitoid/host associations which show different profiles in their functional response to host-patch size.

ACTIVITIES AND FUTURE PLANES OF THE WORKING GROUP "PESTICIDES AND BENEFICIAL ORGANISMS". S.A.Hassan, Institute for biological pest control, Heinrichstr. 243. D-6100 Darmstadt, Germany.

The Working Group aims to encourage international cooperation to: (1) develop internationally approved standard methods to test the side effects of pesticides on beneficial organisms, (2) provide information on the selectivity of pesticides towards important natural enemies of pests, (3) study the interaction between the use of pesticides and the development of insect populations.

Guidelines for testing the side effect of pesticides on 20 beneficial arthropods in the laboratory, 10 in semi-field and 4 in the field were completed. The development of 2, 10 and 11 additional methods respectively is progressing. About 120 pesticides were tested in 6 joint pesticides testing programmes. Rearing methods for natural enemies are being developed. The activities and future planes of the working group will be summarize and testing methods for the egg parasite *Trichogramma* will be given in more details.

THE SOURCE AND ISOLATION OF KAIROMONES FROM *NEZARA VIRIDULA* THAT INFLUENCE THE HOST SELECTION BEHAVIOR OF *TRISSOLCUS BASALIS*.. S.B.Vinson (Dept. Entomology, Texas A&M University, College Station, TX 77843, USA) **L. Mattiacci, S. Colazza,** and **F. Bin** (Agricultural Entomology Institute, University of Perugia, Italy)

Kairomones have been isolated from both the sternal glands and from the adhesive that glues host eggs to the substrate and to each other. The sternal gland material is volatile and appears to attract, the egg parasitoid, *Trissolcus basalis*. The adhesive and the associated kairomone does not appear to attract but stimulates antennation and ovipositor probing.The kairomone associated with the eggs appears to be produced by follicular cells in the egg tube and, along with the adhesive,is applied to the egg prior to oviposition. these two kairomones play different roles in the host selection behavior of *T.basalis*.

STUDIES ON BIOLOGY OF OOENCYRTUS AND ITS APPLICATION IN THE FIELD. Xi-min Chai, Zhi-hua He(Zhejiang Forestry INSTITUTE, Hangzhou,310023 China),Zheng-dong Wu (Changle Forest Farm of Zhejiang Province)

Elm spanworm egg parasite, Ooencyrtus ennomophagus Yoshimoto, was introduced from the United States in 1981. It was 7-8 generations a year and overwintered as a mature larva within the host eggs in Hangzhou, Zhejiang province. The mean development period from egg to adult was 14-15 days in the activity season. The temperature threshold for development and effective accumulated temperature were 9.9±0.5°c and 241.9± 9.2 day-degree, respectively. Adult had a behavior of supplementary nutriment and a sex maturation process (about 5 days). A maximun of 24 offspring were produced by a femal and a mean of 3 host host eggs were parasitized with a maximun of 21. The result of function response test showed that more progeny (24) were produced and high parasitism rate (78%) were occured, whereas the number of offspring emerged from a single egg were less (1.5), and the role of the parasitoid can be full played in proportion as one maternal wasp to 14 host eggs, In the field, the parasitism rate averaged 26% and the horizontal distance of dispersal were about 2.5 metres.

WINTER SURVIVAL STRATEGY OF *ANAPHES* NSP. (HYMENOPTERA: MYMARIDAE), AN EGG PARASITOID OF CURCULIONIDAE. Guy Boivin (Research Station, Agriculture Canada, St-Jean-sur-Richelieu, Québec, Canada, J3B 3E6)

Anaphes nsp. is an egg parasitoid of several species of Curculionidae in eastern North America among them the carrot weevil, *Listronotus oregonensis*. *Anaphes* nsp. overwinters in its host egg in the northern part of its distribution where freezing and cumulative cold damage are major mortality factors. *Anaphes* nsp. is able to maintain a constant supercooling point of -22.9°C throughout its development through a multicomponent system of cryoprotectants based on glycerol-trehalose-fructose. The LT_{50} from cumulative cold damage decreased from 103 days at 0°C to less than 1 day at -20°C.

UTILIZATION OF ARTIFICIAL HOST EGG-WASPS FOR CONTROL OF INSECT PEST IN ARGICULTURE AND FORESTRY . Kai-jia Dai , Zhi-jian Ma , Liang-wu Zhang , Ai-hua Cao (Department of Biology, Wuhan University, Wuhan 430072 , China)

The mechanization of producing artificial host egg cards and propagating wasps by them have been realized in China. The productivity of the assembling line is about 30,000,000 wasps for *Trichogramma dendrolimi* or 20,000,000 wasps for *T. chilonis* per day. Until 1990. the artificial egg-*T. dendrolimi* have been used to control insect pests, such as masson-pine caterpillar, *Dendrolimus punctatus*, ailanthus silkmoth, *Philosamia cynthis*, tobacco budworm, *Helithis armigera*, corn borer, *Ostrinia nubilalis*. The parasitism rates of *Trichogramma* against those pest-eggs mentioned above have reached to 83.36 ± 7.78%, 80.44-85.21%, 92.30 ± 1.58% and 81.88-86.10% respectively. The artificial host egg-*T. chilonis* have been used to control insect pests, such as sugarcane borers, *Chilo infuscatellus, Chilo sacchariphagus indicus, Argyroploce schistaceana*, leguminous pod borers, *Maruca testulalis*, pickleworm, *Diaphania indica*, tobacco budworm, *Heliothis assulta*. The parasitism rates of *Trichogramma* against pest-eggs mentioned above have reached to 81.99 ± 6.61%, 87.39 ± 5.93%, 94.00 ± 4.60%, 90.60%, 94.80 ± 1.09% and 63.61 ± 4.40% respectively. The pratice in controlling 10 kinds of insect pest in total area of 1700 ha indicated that in comparison with natural egg-wasps, the artificial egg-wasps costs much lower when the two kinds wasp have the same effect in control of pest.

USE OF *TRICHOGRAMMA OSTRINIAE* (HYM., TRICHOGRAMMIDAE), TO CONTROL THE ASIAN CORN BORER, *OSTRINIA FURNACALIS* GUEN'EE IN TAIWAN. Ching-Tien, Tseng (Corn Research Center Potzu, Chia-I, Taiwan, China)

One egg card machine has been developed to reduce the costs in the mass production of *Trichogramma ostriniae*. The machine is 10 times faster than laborer in producing egg cards. It saves 2265 hours in every finish of 3,000,000 egg cards (3.5X1.5cm). The freshness of egg cards could be maintained by spraying the preservative agent "Fuyolin" and storing at low temp. The percent parasitism on egg cards treated with "Fuyolin" and stored at 4°C for 15 days, 25 days and 30 days were 76.3%, 54.7%, 40.7% and 34.1% respectively. Combining mass release of *T. ostriniae* with 2 pesticide treatments was more effectively in controlling corn borer on field corn than conventional control. For sweet corn, *T. ostriniae* should be combined with three treatments of *Bacillus thuringinesis* and one of low-toxicity insecticide. In addition, the tassels should be removed before pollen-shedding in two out of every three rows. This gives satisfactory control and profitable return. The mass release of *T. ostriniae* has accumulatively suppressed the corn borer population density form 7.2 male moths captured per virgin female trap 1985 to 4.8 male moths captured per trap 1990 in Chia-I area Taiwan.

IN VITRO REARING OF *OOENCYRTUS PITYOCAMPAE* (MERCET)(HYMENOPTERA, ENCYRTIDAE). L. Masutti, A. Battisti, N. Milani, M. Zanata (Institute of Agricultural Entomology, University of Padova, I-35131 Padova, Italy).

Ooencyrtus pityocampae is a polyphagous egg parasitoid, known mainly as egg parasitoid of the Pine Processionary Caterpillar *Thaumetopoea pityocampa* (Denis & Schiffermüller), a pest of pines in S Europe and in the Mediterranean region.

The use of mass reared *O. pityocampae* for the biological control of *Th. pityocampa* was envisaged by various authors, who did the rearing of the parasitoid on alternative hosts. The rearing on artificial substrates was recently undertaken and after a large screening of both materials and techniques available for this aim, a PVC film and a diet free from insect material were found as suitable for the complete development of *O. pityocampae*. The "artificial" eggs allowed the parasitoid to oviposit and to develop well up to the adult stage. The length of the development and of the adult life were similar to those observed with natural hosts. The females laid viable eggs in both natural and artificial eggs.

Mass production and utilization of Trichogramma for controlling the sugar-cane borers in Egypt . M.S.T.Abbas, Plant Protection Institute,Cairo,Egypt.

Chilo agamemnon is the main insect pest of sugar cane in Egypt. Trials were done to use chemical insecticides against such a pest but the results were rather poor. A project started in 1987 to utilize T. evanescens which occurs naturally in sugar-cane fields with a peak of 90 % parasitism by the end of the season. The project was initiated to release the parasite early in the season when % parasitism does not exceed 5 %. T.evanescens,mass reared on eggs of Sitotroga cerealella, was released in 10 ha in 1987 and in 2000 ha in 1991. Rates of infestation, at harvesting, were reduced by 40 - 80 % .

A central laboratory for mass production of the parasite has been established this spring to release Trichogramma in 15,000 ha within two years. Further laboratories are planned to be established within a few years to cover the whole area of sugar-cane in Egypt (100,000 ha) .

STUDY ON TRICHOGRAMMA MAIDIS PIN., VOEG FOR CONTROLLING CHILO SUPPRESSALIS (WALKER) OF GUILAN PROVINCE, IRAN. Zakaria Karimian, (Plant Pests and Diseases Research Institute Lab. of Guilan P.O. Box 133, Bandar Anzali Iran.)

Trichogramma maidis is the egg parasitic wasp of Chilo suppressalis, the major pest of the rice in the north of Iran, but the natural parasitism is not high enough to control the pest. For practical purpose eggs of Sitotroga cerealella was used for propagating the parasitoid, and we released about 300,000 T.maidis per hec in the 1st and 2nd generation of C. suppressalis, the egg parasitization of C. suppressalis by T. maidis was 60-85% during 1987-89 and effectively controlled by occurrence of the pest. It has been cleared through study that in improved and high yielding cultivars which are more susceptible to C.suppressalis than local ones, the number of releasing should be increased.

Trichogramma pretiosum (Riley): NATURAL AND INDUCED EGG PARASITISM OF TOMATO FRUITWORM IN PROCESSING TOMATOES IN SINALOA, MEXICO. Alvarado-Rodríguez Benito (Campbell Research & Development, Guasave, Sinaloa, Mexico 81000).

Natural parasitism by Trichogramma pretiosum (Riley) on eggs of Helicoverpa zea (Boddie) and Heliothis virescens (F.) commonly occurs at high levels in processing tomatoes in Sinaloa, Mexico. Impact of insecticides and type of applications on rates of parasitism by Trichogramma wasps, that are commonly used for controlling tomato insect pests in commercial fields under different agroecological areas were studied for a two-year period.A study was also conducted to determine optimum field release rate of Trichogramma wasps as to achieve an economic tomato fruitworm control that would complement the naturally occurring parasitism.

Rates of parasitism ranged from 35 to 96%, being lower early in the season and high as season progresses. Differences were detected among agroecological areas depending upon insect control strategies. Total sprays reduced natural parasitism by 40% when compared to peripheral sprays used for controlling the tomato pinworm, Keiferia lycopersicella (Walshingham). Trichogramma wasp releases induced higher egg parasitism with lower fruit damage as compared to the untreated control. Differences were not detected among the rates under study (1'000,000, 750,000 and 500,000 wasps per hectarea).

Trichogramma wasps are an important component of the IPM program developed by Campbell's-SINALOPASTA. This IPM program has been implemented with outstanding results.

THE CONTROL OF THE CABBAGE WORM BY T.EVANESCENS.
Mei-li Lian.Yun-ning Zhou.Tang Li, Xiao-xiu Zhang. Jun-sheng Zhao (Shanxi Plant Protection Institute. Taiyuan 030031. China)

During 1984 to 1988 , we have investigated the species of Trichogramma which parasite eggs of cabbage worms, observed the bionomics of T.evanescens and released them in order to control the worms . Results show that the parasitization rate of the pest eggs by the wasp is 81.17%, absolutely predominant, while T.ostriniae, T.closterae and T. leucaniae in small quantity. The parasite appears in mid May, reach into culmination in July and go to overwinter in mid October with the harvest of cabbage at Taiyuan. Survey in laboratory shows that either eggs of Gorcyra cephalonica or eggs of Antheraea pernyi can be used for mass rearing. Mass releasing of the parasite (30000 adults per mu) during the egg stage of the pest for 1st generation the egg parasite rate is more than 65%. for 2nd and 3rd gen. are above 80%. If we apply the protective implement to release the wasp,the quantity needed is merely 10-20% of that for mass release. Every protective implement can control the worms in a range of 30-40m radius. and parasite rate is more than 60%. Thus. a new way for controlling pests is set up.

USE OF TRICHOGRAMMA DENDROLIMI IN THE CONTROL OF ORCHARD REST INSECTS.
Jianguo Feng, Yong Zhang, Xun Tao (Institute of Plant Protection, Shandong Academy of Agricultural Sciences, Jinan 250100, China)

In last decade, by releasing egg parasite, T. dendrolimi, for controlling leaf-eating insects, Adoxophyes orana and Acrongota increta, and fruit borer, Grapholitha molesta, in the 15000 ha. apple orchards of Weihai city, Shandong Province, the egg parasitization was over 90% and about 85%, respectively. The control effectiveness was 60-80%, higher than that of insecticide application. The test of ^{32}p labbelled wasps showed that among these eggmasses 73.91% was found to bar ^{32}p, which vindicated that the result was of released wasps. 14. 34 cpm radioactivity was detected for single eggmass. In the first 6 hours of release, 91.3% wasps dispersed within 10 meters, a few beyond 20 meters, only 1.09% up to 50 meters. The wasps dispersed evenly within 30 meters by 24 hours. It was demonstrated that the number released in orchards from 1.8 to 3 millions per ha. could all reach over 90% parasitic rate. The wasps always maintained higher parasitic rate, about 80.8-90.65%, but in check orchards it changed widely, with only 17.2% in first vigorous period of egg and 62.5% in the end period. According to the investigation, natural predacious enemies, such as ladybugs, aphid lions and drone flies in the released orchards were about 17 times as many as those in the fields of insecticide application. The larval parasitization of A. orana by 5 species of parasites including Ascogaster recticulatus reached 60.5% in average. Toxicity to wasp varied with various insecticides, organophosphorus insecticides were the strongest.

RESEARCH ON AND APPLICATIONS OF *Anastatus* sp. (Hym.: Eupelmidae) FOR THE CONTROL OF THE LITCHI STING BUG, *Tessaratoma papillosa* (Hem.: Pentatomidae) IN CHINA.
Lin Nai-quan, Tang Yu-qing, Chen Zhu-mei (Biological Control Research Institute, Fujian Agricultural College, Fuzhou 350002, China)

Litchi sting bug, *Tessaratoma papillosa*, is one of the most important pests of litchi (*Litchi chinensis*) and longana (*Nephelium longana*) in tropical and subtropical regions of China. An indigenous egg parasitoid, *Anastatus* sp. had been carefully studied and widely used to control the litchi sting bug in China for nearly 30 years. In this paper, the authors give a review on the main biological and ecological characteristics of *Anastatus* sp., introduce technical methods of mass rearing and report the results of a large scale application in Fujian orchards in recent three years. Paper cards, to which the host eggs of *philosamia cynthia* were glued on, were hung inside a large cage for the propagation of the parasitoid, and are reported for the first time. The efficiency of releasing parasites, promotion of the natural community of *Anastatus*, and harmonious application of biological and chemical control in the orchards are discussed as well.

r and K STRATEGIES IN NATURAL ENEMIES OF DIASPIDID SCALE INSECTS, Aphytis vs. ENDOPARASITOIDS. Shimon Steinberg, Haggai Podoler and David Rosen (Department of Entomology. The Hebrew University of Jerusalem, Faculty of Agriculture. P.O. Box 12, Rehovot 76100, Israel).

Introduction of natural enemies into a new environment is similar to the colonization of an island. This analogy links the theory of r- and K-selection with practical biological control strategies.

Four well-documented cases of utilizing Aphytis species and endoparasitic wasps in biological control of the Florida red scale, the chaff scale, the California red scale in Israel and the California red scale in California, are analyzed. Basic traits such as r_m, host specificity, body size, resource exploitation, intrinsic and extrinsic competitiveness and vulnerability to environmental hazards are compared for the Aphytis species and the corresponding endoparasitoid, in the context of the r- K theory. Each trait is weighed and placed along an r-K continuum, since there are no absolute criteria by which a parasitoid can be designated as an r- or K-strategist. In conclusion, some generalizations are made with regard to r-K selection and the practice of biological control of armored scales insects by Aphytis and endoparasitoids.

Biological Control of the citrus snow scale, *Unaspis citri* in Florida: Evaluation of *Aphytis* and other natural enemy species. By H. W. Browning, University of Florida, IFAS, Citrus Research and Education Center, Lake Alfred.

The citrus snow scale is currently the most important armored scale pest of citrus in Florida following the successful biological control of *Chrysomphalus aonidum* and *Cornuaspis beckii*. Populations of the scale have spread throughout the state where citrus is cultivated, periodically reaching tremendous populations on bark and limbs of commercial and urban plantings. Natural enemy survey prior to intentional introductions indicated the presence of *Aphytis lingnanensis* and *Aspidiotiphagus* spp. attacking this scale, but levels of parasitism were inadequate to prevent grower concern. The 'Hong Kong Strain' of this parasite was collected by Paul DeBach in 1969 and made available for introduction into Florida in 1972. A mass rearing and release program ensued, resulting in the liberation of millions of the parasites throughout infested areas of Florida.

Extensive evaluation was not pursued, and success has been assumed in association with localized reduction in scale populations. Releases of the 'Hong Kong Strain' have not been made since 1985, and recent field evaluations indicate a minimal role being played by *Aphytis* spp. in regulating *Unaspis citri*. *Aspidiotiphagus* parasitization is also being evaluated for comparative purposes. Age-specific parasitism data for these parasites on snow scale are presented. Introductions of *Aphytis lingnanensis* from Thailand via Australia were field liberated in 1991, but evaluation of the impact of this release is limited by our ability to distinguish existing *Aphytis lingnanensis* from introduced material. Current research results and future directions will be presented, highlighting biological information on *Unaspis citri* and alternative natural enemies.

A STUDY ON THE SEARCHING EFFICIENCY OF FEMALE *Aphytis melinus* (Hymenoptera: Aphelinidae) AT 25± 1℃ AND 60% R.H. Zhao Jing-wei (Biological Control Research Institute, Fujian Agricultural College, Fuzhou 350002, Fujian, China)

This was a modified study on the functional response of *A.melinus* on California red scale, *Aonidiella aurantii*. The main characteristics of this study were as follows: (1) very large (up to 4.5m^3) searching universes were offered to the searching parasite wasps, (2) different densities of host scales were presented to the wasps in the same treatment and (3) diferent carbohydrate foods were provided to the searching wasps.

Results indicated that female wasps of *A. melinus* normally searched for scale insects at random. On consideration, the results led to the disagreement of the classical concept of Holling's "functional response". It was belived this was due to the experimental design in this study.In this study, parasite wasps had more freedom for their searching activity under more natural conditions than those given by previous workers.

THE ROLE OF *APHYTIS* IN THE BIOLOGICAL CONTROL OF ARMOURED SCALE INSECTS ON CITRUS IN SOUTH AFRICA. E.C.G. Bedford (Citrus and Subtropical Fruit Research Institute, P/Bag X11208, Nelspruit 1200, Republic of South Africa), Carina J. Cilliers (Plant Protection Research Institute, P/Bag X134, Pretoria).

The leading role of Aphytis spp. in the biocontrol of four armoured scale insects on citrus in South Africa is reviewed. From 1962 to 1966, nine consignments of five species of Aphytis were received from California and produced 9295 adults. Just under a million adults of these five species were mass-reared and liberated from 1962 to 1973 in suitable citrus areas by the two government institutes. A. holoxanthus and A. lepidosaphes gave classical biological control of Chrysomphalus aonidum and Lepidosaphes beckii respectively. A. melinus and A. lingnanensis or A. coheni assisted the indigenous A. africanus to control Aonidiella aurantii. A. lepidosaphes also became an important mortality factor in the control of Lepidosaphes gloverii, a potentially serious pest in a few areas. Integrated spray programmes were introduced simultaneously. Competitive displacement of parasitoids and competition with endoparasitoids is discussed. One or more imported Aphytis species have been established in all areas covered by the 13 million citrus trees in South Africa. This has led to important financial savings of 50 % or more of the costs of sprays alone.

The citrus thrips, Scirtothrips aurantii, is now the major pest in most citrus areas. The citrus psylla, Trioza erytreae, is also a serious major pest, especially in the Transvaal.

THE BIOLOGICAL CONTROL OF OLIVE SCALE, *PARLATORIA OLEAE* (COLVÉE) BY TWO APHELINID PARASITES. C. B. Huffaker, (Division of Biological Control, University of California at Berkeley, 1050 San Pablo Avenue, Albany, CA 94706, U.S.A.), C.E. Kennett, R.L. Tassan and David Rosen

This program was begun by H.S. Smith in 1948 and several species of predatory and parasite species were introduced from the near East and Asia. The scale formerly heavily infested over 200 host plant species and caused drastic losses before the introductions were made. The two significant species which have resulted in complete biological control, are *Aphytis paramaculoconis* DeBach and Rosen and *Coccophagoides utilis* Doutt. The first produced alone a real decline in populations, but not always. With the addition of *C. utilis*, infestations on olive, intensively studied, and all other crops have declined to insignificance. *Aphytis* is still the most important, but *C. utilis* adds a necessary complementary action, especially during the hot dry summers. *Aphytis* appears definitely to act in a positive density-dependent way, and, despite the negative density-dependent action of *C. utilis* The latter adds a great degree of security against upsets from use of pesticides against other pests. An intensive study on prunes showed similar success and can be used in combination with chemicals in an integrated pest management program.

ROLE OF *APHYTIS YANONENSIS* IN THE BIOLOGICAL CONTROL OF ARROWHEAD SCALE IN JAPAN. Kaichi Furuhashi (Shizuoka Citrus Experiment Stn.,2-12-10 Komagoenishi Shimizu-shi,Shizuoka-ken,424, JAPAN)

The arrowhead scale, *Unaspis yanonensis* Kuwana, has been one of the most important insect pests on citrus in Japan since around 1930.The arrowhead scale is believed have originated in China.In 1980,one of entomologist of the Shizuoka citrus experiment station visited to mainland China to find natural enemies of the arrowhead scale,and succeeded in collecting *Aphytis yanonensis* DeBach and Rosen. The number of generation a year was estimated to be 10-12 by caluculating of total effective temparature,five or six times as many as that of arrowhead scale.

Two years after the *A.yanonens* is had been released ,there was high rate of parasitism and the density of arrowhead scale declined markedly to be lower than economic injury level.Several citrus growing Prefecture started the mass rearing of the *A.yanonensis* since 1983, and it had dispersed over more than 10 km,with a maximum of 20 km during only one year.It is now found neary everywhere in Japan where citrus growing area.

DELAYED EFFECTS OF PESTICIDES ON HYMENOPTERAN PARASITE: THE ROLE OF THE SCALE COVER OF DIASPIDID INSECTS. Ephraim Cohen, Mohammad El-Hamalawi, Haggaii Podoler (The Hebrew University of Jerusalem, Department of Entomology, Faculty of Agriculture, Rehovot 76 100, Israel).

Diaspidid insects are characterized by a waxy and relatively thick scale cover which plays a significant protective role against physical and chemical assault. Due to their lipophilic nature these scales absorb and retain part of applied pesticides. Thus, females of the Florida red scale Crysomphalus aonidium were considerably more sensitive to malation when applied to insects from which covers were removed. Upon their emergence adults of the exoparasite Aphytis holoxanthus were exposed to lethal levels of the organophosphorus insecticide retained in the compartment of the host shield. However, immature stages of the parasitoid were not affected by malathion previously applied on the host. Mortality of adult parasitoids was observed even 14 days after treatment with malation. As a given pesticide dissipates in the environment, it may be protected and retained inside scale covers of diaspidid insects. This retention, and as a result the delayed effect of pesticides on nontarget beneficial insects, may explain some failures in biological control of diaspidid pests.

MORPHOMETRIC COMPARISONS OF *APHYTIS* SPECIES IN THE *LINGNANENSIS* GROUP, AND PRELIMINARY DNA SEQUENCE DATA. James B. Woolley, Mike Rose and Pete Krauter, Department of Entomology, Texas A&M University, College Station, Texas 77843, USA. Size and shape differences in adult female *Aphytis* (Hymenoptera: Aphelinidae) were characterized by digitization of homologous landmark points on the antennae, ovipositors, dorsum of mesosoma and fore wings. Landmarks were chosen to represent shape differences between forms and for accuracy in location. Distances between landmarks were analyzed by principal component analysis, discriminant analysis and canonical variates analysis. Specimens of the following were examined: *Aphytis lingnanensis* from *Aonidiella aurantii* and *Diaspis echinocacti* from California, from *Unaspis citri* from Florida and from *Insulaspis gloverii* from Texas and Mexico, and *Aphytis yanonensis* from *Unaspis yanonensis* from Japan. Mitochondrial DNA was extracted from progeny of female isolines of *A. yanonensis* and *lingnanensis* (*Unaspis* race) and a 600 bp portion of the 16s ribosomal sequence was amplified and sequenced using asymmetrical PCR and cloning methods (*yanonensis*) or cloning alone (*lingnanensis*). Results indicate a surprising amount of divergence for two closely related species (approximately 20%), suggesting that the 16s sequence has considerable information for species-level systematics in *Aphytis*.

THE APHYTIS FAUNA OF THE AUSTRALIAN REGION. Dahms, Edward Clive (Queensland Museum, PO Box 3300, South Brisbane Q 4101, Australia).

Rosen and De Bach (1979) list 18 species of *Aphytis* from Australia which compares favourably with other regions. Most of the species were described by A.A. Girault without host data. Australia is poorly sampled taxonomically with most type localities being in coastal Queensland around Brisbane and Cairns. Diaspididae (*Aphytis* hosts) in Australia are rich in species, but the fauna is estimated at only 20% known. It is reasonable to assume that the Australian *Aphytis* fauna may be coincidentally rich.

Of the 43 principal pest species of diaspidids in the world 24 are known from Australia. *Aphytis* species being used for biological control include *A. melinus, A. chrysomphali* and *A. lingnanensis*.

THE APHYTIS FAUNA OF THE AFROTROPICAL REGION (HYMENOPTERA: APHELINIDAE). G.L. Prinsloo (Biosystematics Division, Plant Protection Research Institute, Private Bag X134, Pretoria, 0001, South Africa)

Aphytis Howard, the species of which are primary endoparasitoids, is the largest of the nine aphelinid genera associated with Diaspididae in the Region. Thirty described and 4 undescribed species (about 33% of the known world fauna) are known from the Region.The Afrotropical fauna comprises three elements: species that have been deliberately introduced for biological control purposes (5 spp.); those that have been accidentally introduced (5 spp.); and those believed to be indigenous (24 spp.). Mosts species and their hosts are known only from southern Africa, where these faunas have been extensively sampled. This allows certain extrapolations regarding the distribution of the genus Aphytis elsewhere in the Region. A small proportion of the fauna is probably confined to the southern subregion, while the majority of species are thought to be widespread in sub-Saharan Africa with some occurring in other zoogeographical regions as well. Known hosts include 37 species in 29 genera of Diaspididae, while a significant number of diaspidids in the Region do not seem to act as hosts. Host species belonging to very widespread genera seem to be preferred to those of endemic genera; only 4 of the 29 genera are confined to the Afrotropical region, the remainder occurring elsewhere as well.

SPECIES OF APHYTIS OCCURRING IN CHINA AND THEIR ROLE IN BIOLOGICAL CONTROL. Hui Ren (Guangdong Entomological Institute, Guangzhou 510260, China)

22 species of Aphytis are recorded occurring in China with a description as new, and their role in biological control. These species are A. acalcaratus, A. chionaspis, A. chrysomphali, A. comperei, A. confusus, A. debachi, A. diaspidis, A. gordoni, A. hispanicus, A. holoxanthus, A.lepidosaphes, A. lingnanensis, A. longicaudus, A. maculicornis, A. melinus, A. mazalae, A. mytilaspidis, A. nigricornis sp.nov., A. philippinensis, A. proclia, A. vandenboschi, A. vittatus, A. yanonensis.

SPECIES OF APHYTIS OCCURRING IN THE USSR AND THEIR ROLE IN BIOLOGICAL CONTROL. Valentina A. Yasnosh (Dep. of Biological control. Georgian Sci. Institute of Plant Protection 380062-Tbilisi, Chavchavadze av. 82. Georgia)

The Aphytis fauna (Hymenoptera: Aphelinidae), parasites of armoured Scales (Coccinea: Diaspidiдae) consists of 14 Species which are distributed; 12-in European part and on the Caucasus, among them 7-on Black Sea coast and 5-in Transcaucasian region, 6-in Central Asia and 5-on Far East (Vladivostock) where two new species recently are registrated- *Aphytis stepanovi* Jasnosh, sp. n., *A. wandenboschi* De Bach and Rosen. The role of Aphytis species in biological control and the perspectives of new species introduction are discussed.

BIOLOGY OF *ERETMOCERUS*. Dan Gerling, (Tel Aviv University, Dept. Zoology, Israel), Tom Bellows (University of California, Dept. Entomology, Riverside, U.S.A.)

All *Eretmocerus* are solitary whitefly parasitoids. They are unique as immatures both in larval morphology and developmental mode that combines features of both endo- and ecto-parasitism. The egg is laid between the leaf and the host and the newly hatched first instar larva influences the host's development by injecting materials into it.

Host finding is modulated by honeydew that acts as a kairomone and an arrestant. The number of suitable hosts attacked is usually less than those available on the patch.

Host quality is often determined only through antennal evaluation following host contact. This can be followed by search for another host or by ovipositor probing. The latter is followed by oviposition, by further evaluation of the same host, or by continued search without oviposition. Antennal evaluation times leading to ovipositor probing are longer than those leading to rejection. Similarly, ovipositor probing times leading to oviposition are longer than those followed by rejection.

Host feeding follows ovipositor insertion into the anal opening in some species, or ovipositor probing beneath first host instar in other species.

WHITEFLY MORPHOMETRICS AND MIGRATION. David N. Byrne and Jacquelyn L. Blackmer (Department of Entomology, University of Arizona, Tucson, AZ, 85721,U.S.A.)

Using morphometric techniques, Byrne and Houck recently established that the sweet potato whitefly, *Bemisia tabaci* (Gennadius), is polymorphic in wing configuration which suggested the existence of a migratory and a nonmigratory morph. Laboratory experiments using a vertical flight chamber confirm that there are behavioral differences as well. There is modality among groups of whiteflies from the same population. One group flies for less than 10 min while the other flies for more than 40 min. It has not been uncommon for whiteflies to fly for more than 2.5 hr. Although rates of ascension are not high (approximately 5 cm/sec), the fact that these insects can stay airborne for such a long period indicates that long range migration is possible even at low wind speeds. We have also found that males fly longer than females and that most flight takes place during early morning hours. Laboratory experiments are being conducted to determine if there are proximal cues (e.g., host plant quality, photoperiod and crowding) that females respond to that results in the production of migratory offspring. Field work continues to determine how far whiteflies can travel between patches (crops).

BIOLOGICAL CONTROL OF WHITEFLIES WITH ENTOMOPHAGOUS FUNGI. L.S. Osborne (Univ. Florida, IFAS, CFREC, 2807 Binion Rd., Apopka, FL 32703), Z. Landa (Agric. Univ., Faculty of Agronomy, Dept. Plant Protection, Studentska 13, 370 05 Ceske Budejovice, Czechoslovakia), J.E. Wright (USDA, Subtropical Agricultural Research Lab., 2413 East Highway 83, Weslaco, TX 78596).

The prospects for biological control of *Bemisia tabaci* in the southeastern United States and elsewhere using entomopathogenic fungi will be discussed. We will present an overview of research in progress on managing this whitefly with *Paecilomyces fumosoroseus*, *Aschersonia aleyrodis*, *Beauveria bassiana*, and *Verticillium lecanii*. All of these pathogens offer great potential as a basic component of IPM programs for the management of *Bemisia tabaci*. Each pathogen has unique properties that make it better suited for specific situations. Interactions between these pathogens and other biological control agents, mycophagous mites (*Acalvolia* sp.), the host plant and *Bemisia tabaci* will be discussed.

MODELLING THE TRITROPHIC INTERACTION BETWEEN HOST PLANT, GREENHOUSE WHITEFLY AND ITS PARASITOID *ENCARSIA FORMOSA* ON A SINGLE LEAF. H.J.W. van Roermund and J.C. van Lenteren (Department of Entomology, Wageningen Agricultural University, P.O.Box 8031, 6700 EH Wageningen, the Netherlands).

A stochastic simulation model has been developed to simulate the functional response of the parasitoid *Encarsia formosa* on a tomato leaflet infested with immatures of *Trialeurodes vaporariorum*. Input parameters of the model were obtained from (behavioural) observations and are the number and size of each immature, the width of the searching path of the parasitoid, the walking speed, the activity, the success ratio, the handling time, the giving-up time, the number of mature eggs, leaf area and temperature. Output of the model is the number of hosts parasitized and the number killed by host-feeding. The functional response will be used as input in another simulation model of the tritrophic interaction between host plant, greenhouse whitefly and *E. formosa* in a crop. Goal is to gain better insight into the complex system which is essential to understand wether biological control is feasible.

A NEW BIOTYPE OF BEMISIA TABACI: INTERACTIONS WITH PLANTS AND VIRUS EPIDEMIOLOGY. R.K. Yokomi, D.R. Jimenéz, J.P. Shapiro (USDA, ARS, Orlando, FL, USA); J.E. Duffus (USDA, ARS, Salinas, CA, USA); J.K. Brown (U. Ariz., Tucson, USA); and J. Bird (U. Puerto Rico, Rio Piedras).

A new Bemisia tabaci biotype identified as the "B strain," with unique biological and genetic properties, was first noted in Florida in 1986 and has spread rapidly throughout the southern U.S. and Caribbean Basin. Enormous infestations of the "B strain" in a variety of vegetable and fiber crops have resulted in plant virus epidemics and several new phytotoxic disorders including squash silverleaf (SSL). Although the "B strain" contained specific double-stranded (ds) RNA bands, SSL could not be attributed to a plant virus. The indigenous "A strain" of B. tabaci induced attenuated to no SSL symptoms under test conditions and did not contain dsRNAs. SSL was characterized as a developmental phytotoxemia induced by whitefly feeding since removal of "B strain" whiteflies resulted in recovery from the disorder. Studies of vector/virus relationships conducted in independent laboratories suggests variability in efficiencies of transmission depending on the specific virus and possibly, in part, the host plant species. The concept of "race" or "biotype" of B. tabaci conceived in the 1960's (J. Bird) has received widespread attention in light of these recent occurrences.

IXS-8 How Plants Affect Behaviour, Fitness and Performance of Natural Enemies

NUTRITIONAL VALUE OF PLANT MATERIALS TO NATURAL ENEMIES. Frank Slanksy (Department of Entomology-Nematology, University of Florida, Gainesville, Florida 32611, USA), Dale G. Bottrell (Entomology Division, P. O. Box 933, 1099 Manila, Philippines)

Some 75% of predatory and parasitic insect families include entomophagous species that may consume plant tissues or products during one or more of their life stages. Nectar, pollen, honeydew, plant juices, and seed eliasomes are examples of plant materials that entomophages consume. Available data on the nutritional role of plant materials in natural enemy performance suggest three main roles: the plant materials prevent starvation when prey is scarce; the materials enhance performance even when prey is adequate; or the materials are essential for the non-carnivorous life stage(s) of the omnivores. There is limited information on how variation in the quality of plant tissues and products affects survival and reproductive performance. Analysis of potential nutrient composition suggests that nectar or honeydew may provide a complete source of water or energy. Pollen is more nutritionally complete with a much higher concentration of amino acids, more complete mix of essential amino acids, and a range of fatty acids and sterols.

EFFECT OF RICE GENOTYPE ON FITNESS AND PERFORMANCE OF NATURAL ENEMIES. Dale G. Bottrell (Division of Entomology, International Rice Research Institute, P. O. Box 933, 1099 Manila, PHILIPPINES)

The attraction to and performance of insect predators and parasitoids were measured on rice genotypes representing a wide range of genetic diversity and different stages of maturity in the laboratory. In wind tunnel studies, only two rice genotypes were significantly attractive to Tetrastichus schoenobii, a parasite of eggs of the yellow stemborer, Scirpophaga incertulas. In olfactometer studies, 6 of the 15 genotypes were significantly more attractive than the others to the generalist predator Cyrtorhinus lividipennis. Three rice genotypes were significantly more attractive than the others to another generalist predator, Micraspis hirashima. The phenological stage of the rice plant had limited effect on parasitoid or predator response in the wind tunnel or olfactometer. The type of rice also significantly affected the development and performance of M. hirashima. The plant mechanisms involved and implications for enhancing natural enemy performance through rice breeding are discussed.

EFFECT OF PLANT HABITAT ON PARASITOID PERFORMANCE. Moshe Coll (Department of Entomology, University of Maryland, College Park MD 20742, USA).

The presence of nonhost plants in a habitat often affect the ability of parasitoids to locate and parasitize their hosts. However, how specific features of vegetation texture affect parasitoids is poorly understood. Yet, insights into the effect of plant texture on natural enemies are important in developing predictive theories and biological control practices.

Results from a field study show that the presence of tall nonhost corn plants in a bean habitat reduced immigration of Pediobius foveolatus, a parasitoid of Mexican bean beetle larvae. However, the wasps favored the shaded conditions created by the corn. Through its effect on bean plant quality, the tall corn also provided the parasitoid with more suitable host larvae. As a result, more wasps and proportionally more females emerged from hosts in shaded habitats. These effects were independent of bean and host density and plant species diversity. Therefore, the relative importance of both direct and indirect effects will determine parasitoid performance in different plant habitats.

CAN SYNERGISM BETWEEN PLANT TOXINS AND NATURAL ENEMIES INFLUENCE HERBIVORE EVOLUTION? Fred Gould, M. Tracy Johnson and G. G. Kennedy (Dept. Entomology, North Carolina State Univ., Raleigh, N.C. 27695-7634)

Many entomologists assumed that the use of partial plant resistance coupled with the action of natural enemies offered a more sustainable approach for pest management than the use of strong plant resistance. This view assumed that pests would adapt to the combination more slowly because plant toxins and natural enemies are such distinct sources of mortality. A computer simulation that examined the rate of insect adaptation to partially resistant plants in the absence and presence of natural enemies demonstrated that natural enemies can increase or decrease the rate of pest adaptation to partially resistant plants. The direction of the effect of natural enemies is determined by the type of partial resistance and the predators' search behavior. Field experiments involving ambient levels of natural enemies, Heliothis virescens larvae, and partially resistant tobacco that expressed low levels of the Bt-toxin, CryIA(b), indicate that in this system, the natural enemies are expected to increase the rate at which natural enemies adapt to partially resistant, bioengineered tobacco.

EFFECT OF SOYBEAN GENOTYPES ON THE BEHAVIOR, FITNESS AND PERFORMANCE OF INSECT NATURAL ENEMIES. Raman Ramachandran (Dept. of Entomology, UW-Madison, WI 53706, USA)

Microplitis demolitor (Braconidae: Hymenoptera) is a parasitoid that develops successfully in soybean looper, Pseudoplusia includens (Noctuidae: Lepidoptera). Volatiles from plant host comptex plays an important role in the host selection behavior of M. demolitor. I discuss here the isolation and identification of two plant based kairomones from the frass of soybean looper larvae for M. demolitor. The influence of soybean genotype on the production of the kairomone is discussed. There results will be discussed along with other published information on the influence of soybean genotypes on behavior, fitness and performance of insect natural enemies.

ENHANCING BIOLOGICAL CONTROL USING KNOWLEDGE ON PLANT-NATURAL ENEMY INTERACTIONS. Peter Kareiva (University of Washington, Seattle, WA 98195, USA)

Three decades ago, root proposed the "resource concentration hypothesis" as an explanation for why pest attack may be exacerbated in large, pure stands of crops. This hypothesis emphasizes the interaction between vegetation structure and herbivore searching behavior. It is important to realize that vegetation also influences the searching behavior and effectiveness of predators and parasites. Using models and field experiments, we examine the way in which plants may alter the balance between herbivores and their natural enemies, thereby constraining, or enhancing, the effectiveness of natural enemies as agents of pest management.

INSECT POPULATIONS ON SUSCEPTIBLE AND RESISTANT VARIETIES IN THE PRESENCE AND ABSENCE OF NATURAL ENEMIES. R.D. Eikenbary and R.K. Campbell (Department of Entomology, Oklahoma State University, Stillwater, OK. 74078 U.S.A.)

Breeding for plant resistance to insects and mites changes plant quality and this may affect entomophagous species in the laboratory, greenhouse, and field situations. The effects of resistant and susceptible plant hosts passed through herbivores to beneficial insects will be discussed. The plant hosts, herbivores and beneficial insects to focus upon include: cereal grains with herbivores Schizaphis graminum and Diuraphis noxia and parasitoids Lysiphlebus testaceipes and Diaeretiella rapae; soybeans with herbivore Nezar viridula and parasitoid Telenomus chloropus, also on soybean, herbivore Pseudoplusia includens and parasitoids Microplitis demolitor and Copidosoma truncatellum and predator Podisus maculiventris; potatoes with herbivore Leptinotarsa decemlineata and egg parasitoid Edovum puttleri; cotton with herbivores Heliothis spp., Aphis gossypii and Anthonomus grandis with natural enemies, etc. Examples of such interactions include a lengthened parasitoid developmental period, more male biased sex ratio and reduced fecundity on a resistant wheat line when drought stressed; and that the fecundity of an egg parasitoid was reduced by half when reared on pentatomid eggs on a resistant soybean genotype.

THE EFFECT OF MORPHOLOGICAL CHARACTERS OF RESISTANT VARIETIES ON NATURAL ENEMIES. John J. Obrycki, (Iowa State University, Department of Entomology, Ames, Iowa, 50011, USA)

The effects of morphological resistance factors on entomophagous species range from detrimental to beneficial. Resistant plant varieties can influence natural enemies by altering searching behaviot, successful host/prey finding due to reduced pest densities, and host/prey suitability due to feeding on plants of reduced nutritional quality. Foliar morphological factors (e.g., pubescence and surface waxes) have been shown to influence the behavior of several predatory and parasitic species. Additionally, anatomical adaptations of plant organs directly effect the searching activities of natural enemies. An understanding of the interactions between natural enemies and resistant varieties makes it possible to minimize detrimental effects of morphological characteristics. Examples will be discussed in which breeding programs for selective foliar morphology have enhanced biological control.

SYNOMONES AND KAIROMONES FROM PLANTS AND HONEYDEW IN SUSCEPTIBLE AND RESISTANT VARIETIES; THEIR IMPORTANCE TO NATURAL ENEMIES.
W. Powell (Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, Herts. AL5 2JQ, U.K.)

Specialist natural enemies, such as insect parasitoids, respond to semiochemical cues from the food plants of their phytophagous hosts during host location. There is also evidence that plant synomones play a role in host recognition during encounters with host individuals. Also, the honeydew excreted by sap-sucking insects contains chemicals which act as kairomones, stimulating parasitoid host-searching behaviour. Plant synomone quantity and/or quality may vary between resistant and susceptible plant varieties, as may the quantity and/or quality of kairomones in the honeydew produced by insects feeding on those varieties. Some parasitoids spend longer searching the plant variety on which the individual host from which they emerged had been fed. This offers opportunities for the production of parasitoid strains with a preference for selected resistant varieties. However, aphids feeding on resistant varieties produce less honeydew and this could have an effect on parasitoid searching efficiency. Fewer encounters with honeydew kairomones could reduce parasitoid searching times but could also reduce time spent cleaning due to reduced honeydew contamination of the parasitoids antennae.

MOVEMENT OF PREY THROUGH DISTURBANCE BY NATURAL ENEMIES AND THE IMPLICATIONS OF VARIETAL DIFFERENCES IN SUCH MOVEMENT. G. R. Gowling (Bunting Brinkman Bees b.v., Mechtildisstraat 2, 5021 CN Tilburg, The Netherlands).
The control of aphid populations by parasitoids and predators can not be totally explained by the rate of parasitism and predation observed on the plant (that is, the number of mummies formed or aphids eaten). In glasshouse studies, the aphid, Metopolophium dirhodum showed increased movement in the presence of the parasitoid, Aphidius rhopalosiphi, leading to disturbance and mortality of the aphid. These disturbances were important factors for measuring the controlling potential of the parasitoid. Moreover, M. dirhodum populations on partially resistant cultivars of wheat were controlled more effectively by the parasitoid when compared to those on susceptible ones. This greater potentiation was partially explained by the increased movement of aphids in the presence of parasitoids on the partially resistant cultivar when compared to those on susceptible ones.
Field studies on the cabbage aphid, Brevicoryne brassicae and its predator/parasitoid complex on susceptible and partially resistant cultivars of Brussels sprouts, suggested further examples of this phenomenon.

TOXIC ALLELOCHEMICALS IN RESISTANT VARIETIES AND NATURAL ENEMIES; WIDER IMPLICATIONS IN PEST MANAGEMENT AND ON THE DEVELORMENT OF HOST PLANT RESISTANCE BY TRANSGENIC METEODS. H.F. Van Emden (Department of Horticulture, The University, Reading, Berks RG6 2AS U.K.).

Plant resistance based on allelochemicals may well be damaging to natural elemies. Alkaloids and other allelochemicals involved in antibiosis have been shown to be toxic to parasitoids with in hosts and toxic or sterilising to predators. In some insects, allelochemicals sequestered by the active stages are passed into the eggs, decreasing egg predation. Another effect of allelochemicals in to increase the tolerance of pests to insecticides. Most other plant resistance mechanisms have the opposite effect and improve the possibilities for using pesticides in a more selective way in favour of biological control. It is argued that plant resistance developed by transgenic methods is particularly likely to be damaging to biological control.

MAKING MICROBIAL PESTICIDES WORK IN THE FIELD: AN OVERVIEW. Donald W. Roberts (Insect Pathology Resource Center, Boyce Thompson Institute, Tower Road, Cornell University, Ithaca, New York 14853 USA)

For the past thirty years, microbial control of insects has been dominated by one agent, *Bacillus thuringiensis* (Bt). The discovery of dipteran- and coleopteran-active strains, improvements in formulation, new ways to study toxins, e.g. toxin receptors, and expression of Bt toxins in transgenic plants, has stimulated extensive research and commercialization worldwide. Recent instances of Lepidoptera developing tolerance to Bt has caused considerable worry, and field and laboratory experiments are underway to circumvent this problem. In the past five years, interest in using entomopathogenic fungi and viruses has increased markedly in response to new agents and development in delivery systems and formulations. Although genetic engineering holds great promise for producing effective microbial control agents and numerous laboratories are conducting research in this area, the regulatory difficulties associated with their release has impeded their practical utilization. Industrial support for microbial control, is at an all-time high. A number of very large international pharmaceutical and agricultural chemical companies have recently entered into this arena, and several small and mid-level companies have attracted substantial financial resources. A combination of strong pressure from governments worldwide to reduce chemical pesticide usage, along with the improved reliability of microbial control agents, holds promise for these agents being increasingly important in pest control through the 1990s and beyond.

FUNGAL PATHOGENS FOR THE CONTROL OF SOIL PESTS. Clayton W. McCoy (University of Florida, IFAS, Citrus Research and Education Center, Lake Alfred, Florida, 33850, U.S.A.)

Entomopathogenic fungi infect all developmental stages of many insect. A number of fungal species representative of the genera Beauveria, Metarhizium, Paecilomyces and Cordyceps inhabit the soil and inflict mycosis to many insects, particularly the larval stage. Selective strains of B. bassiana, M. anisopliae and P. fumosoroseus with high virulence to a broad range of soil insects and a potential for mass production are under development by industry and governmental agencies throughout the world as mycopesticides. Novel conidial, mycelial and bait formulations with improved product stability have been developed and are being field tested for the control of particular weevil and grub larvae at this time. Although biological activity of these fungi is influenced by both abiotic and biotic factors common to a geographical region, the LC_{50} is consistent for conidial formulations of the above fungal species ranging from 1 x 104 to 1 x 105 conidia/g of soil to achieve 80-90% control of host larvae. Mycelial formulations are more dependent on the soil environment for maximum conidiation and subsequent larval mycosis but appear to be more stable as products. Bait formulations have been particularly effective against subterranean pests such as cockchafer that forage on the soil surface. Today, fewer chemical pesticides with satisfactory residual activity are available to agriculture; fungi as biopesticides will fill the void in many countries.

BACTERIAL PATHOGENS FOR THE CONTROL OF SOIL DWELLING PESTS. T.A. Jackson (MAF Technology, PO Box 24, Lincoln, New Zealand)

The soil environment acts as a reservoir for many insect pathogens, encouraging the idea that control of pest species can be achieved by artificial application of pathogens. Strategies for use will depend on characteristics of both pathogen and host and vary from inoculative to inundative approaches. In the USA, *Bacillus popilliae* has been used for more than 50 years as an inoculative control agent for Japanese beetle. An inundative approach is used for control of grass grub by *Serratia entomophila* in New Zealand. The success of the *Serratia* programme is due to development of a system for production and delivery of a high quality product which allows bacterial establishment in the soil and recycling through the target population. The use of bacteria for the delivery of toxins to the soil for other pest species is under consideration and the incorporation of bacterial toxins into plants will also be discussed.

CURRENT SITUATION OF BEAUVERIA BASSIANA FOR PINE CATERPILLAR CONTROL AND ITS PROSPECT IN CHINA. Fengming Ying (Forest Research Institute of Guangdong, China)

Beauveria bassiana (Bals) Vuill has been isolated to control pine caterpillars in China since 1958, and good control results were obtained. Researches such as biological characteristics, pathogenesis, breeding and improvement of strains, production technology, formula of agent, methods of use, safety to human being and livestock have been carried out. Nowadays, Beauveria bassiana is being extensively used in large scale in China, over 3000 tons of powder agent was produced and 800000ha forest can be controlled annually, make up 46.4% total control area of pine caterpillars. 5 billion spore/g powder agent or 120 billion/g spore powder is produced by three-stage solid fermentation and machinery isolation. 7-8 kg/ha of powder agent of 130 g/ha spore powder can be used in forest with 3000 ml of mineral oil, emulsion oil or adjuvant ES-87 by powdery gun and aerial dusting, or by ultra low volume spray. The control result is over 70-80% and the cost for each ha is only 10-15 yuan.

USING BACILLUS THURINGIENSIS FOR CONTROLLING INSECT PESTS IN CHINA. Zhong-yun Peng, Shenzhen Research Centre of Agricultural Sciences, Guangdong 518034, China)

In China, Bacillus thuringiensis preparation has been used for 30 years. In 1976, 1000 ton of industry Bt product(powder) was used to control pest in 66600 ha. of crops. Since 1985 when we developed and used Bt liquid(emulsion) preparation, the development has rised unprecedentedly. In 1991, 5000 ton was used in 300000 ha. of rice and cotton separately, 200000 ha. of fruits and vegetables, in more then 20 provinces of China, specially to control the resistant pest as diamondback moth.

Experiment and practical use has shown that Bt is toxic to 120 species of insects, among them more than 20 are important with the effect of 80% .

To expand control range, quicken the death of pest, heighten the control effect under low tempereture, reduce the use and remain of chemical pesticides, we mixed trace chemical insecticides such as pyrethrin, padan, to Bt preparation and it has made good effect.

BACTERIAL PATHOGENS FOR THE CONTROL OF INSECT PESTS ON PLANT WITH REFERENCE TO DEVELOPING COUNTRIES. H.S. Salama (National Research Centre, Dokki, Cairo, Egypt).

The status of the microbial control agent Bacillus thuringiensis (B.t.) and its use in some developing countries are reviewed with reference to fermentation and production technologies adopted and field application against local insect pests. Efforts for the survey and isolation of new B. t. varieties and screening of their insecticidal activity spectra, potency against developmental stages of some isect pests and safety of the pathogen to parasites and predators are described. Promising new simple fermentation technologies for production of this bacterium in developing countries are discussed. Also discussed are the agro-industrial byproducts used as major components in fermentation media which show great promise for reducing production cost. The technologies used in production of B. t. are described in different localities. Attention is given to promising novel biochemical avenues that have been adopted in Egypt to increase the potency of B.t. varieties to widen their spectra of activity and to overcome their short persistence. In this connection, feeding stimulants, bait formulations, simple non-toxic chemical additives and photoprotectants have been used with great success. Research efforts on the genetic engineering of B. t. in some developing countries are reviewed. These aimed to develop UV and temperature resistant strains and develop crop plants resistant to insect attack. Data on the activity of combinations of B.t.varieties or B.t. and chemical insecticides against some insects are given.

USE OF VIRUSES FOR INSECT CONTROL IN BRAZIL. Flávio Moscardi and Daniel R. Sosa-Gomez, EMBRAPA/National Soybean Research Center (CNPSo), 86001 Londrina, Paraná, Brazil.

The development of viruses as microbial insecticides in Brazil has gained impulse in the last decade, specially after 1982, with the successfull implementation of a programme for the utilization of a nuclear polyhedrosis virus (NPV) of the soybean caterpillar, Anticarsia gemmatalis, at farmer level. This programme, developed by EMBRAPA/CNPSo, resulted in a gradual increase of NPV use against this insect, which is the major defoliator in ca. 10 million hectares of soybeans in Brazil. Currently, the virus has been applied either as crude preparations or as a wettable powder formulation in ca. 1.0 million ha annually. Recently, four private industries started producing and commercializing the NPV, which is expected to bring about a substantial increase in the area treated with the entomopathogen. Other viruses being employed in Brazil are a granulosis virus (GV) of Erinnyis ello (cassava caterpillar), used in over 5,000 ha annually, a GV of Diatraea saccharalis (sugarcane borer), used experimentally in small areas, and a NPV of Spodoptera frugiperda (fall armyworn), which has been produced by the National Corn and Sorghum Research Center (CNPMS) of EMBRAPA, and distributed to farmers since 1990 for controlling the insect on corn.

TECHNIQUES FOR ENHANCING THE EFFICACY OF ENTOMOPATHOGEN SPRAYS AGAINST INSECT PESTS

Roy Bateman, International Institute of Biological Control, Ascot, Berks, SL5 7TA, England.

Under suitable conditions, entomopathogenic fungi belonging to the Deuteromycotina are highly virulent and potentially useful control agents. Isolates of *Metarhizium flavoviride* and *M. anisopliae* have been identified which are highly virulent against various acridid species. Although it was previously thought that they would infect only at very high humidities, it has been shown that oil-based formulations of conidia can infect locusts at 35% RH and 30°C.

This paper reviews methods for entomopathogen spraying and describes recent research using controlled droplet application (CDA) techniques. High locust mortality has been obtained in tests carried out in the Sahel with oil-based formulations of conidia at ultra-low volume (ULV) rates of application. These findings greatly increase the potential of using mycopathogens for practical pest control.

REVIEW ON STUDY, PRODUCTION AND APPLICATION OF BEAUVERIA BASSIANA IN CHIA. Qing-feng Xu (Hefei Institute of Economics and Technology, Hefei 230052, China)

The fungus B. bassiana has been studied in China long before. The application area has been about 0.7 million ha. every year.

Selection for high virulent strain had been focused. Study on isozymes, sero-imunity and protein enzeme patterns to differentiate activity and close relationship were worked out. Study of genetic breeding has been also conducted:

About 40 agricultural and forestry pests were successfully controlled by B. bassiana, but 3 pests has been controlled in larger area. Ecology of epizootic disease of the pine caterpiller has been studied and management model was proposed. Use of another species B. brongniartii to control grubs (Holotrichia spp.) also resulted in good results.

Study of industrial production of B. bassiana got obvious progress recently. The new technological procedure can yield pure spores about 100-180 billion spores/g, which were then made into eattable powder (5 billion spores/g).

Safety of B. bassiana also was studied. Acute toxity, subacute toxicity and chromic toxicity-pathogenicity has been worked out, nor was there any function of causing mutation, teratogenity and carcinocenicity to the white mice.

UTILIZATION OF THE FUNGUS *Sporothrix insectorum* (Hoog and Evans) AGAINST THE LACE BUG *Leptopharsa gibbicarina* (Froeschner) IN OIL PALM PLANTATIONS. Ana-Isabel David-Henriet* and Philippe Genty** (*Laboratoire de Zoologie, CNRS-URA 674, Faculté des Sciences, 6 Bd Gabriel, 21000 DIJON - France. ** A.A. 1535 Indupalma, Bucaramanga, Colombia)

In South America, one the most economically important pest of the African Palm *Elaeis guineensis* (Jacq) plantations is the lace bug *Leptopharsa gibbicarina*, Hemiptera : Tingidae, which is the indirect vector of the foliar mildew complex. This complex associated with the lace bug and the plant pathogen *Pestalotiopsis spp.*, is an endemic problem in the Central and Northern regions of Colombia.

Chemical signals emitted by withering oil palm trees and sound ones are different. The comparison with similar study carried out in Brasil on *Hevea brasiliensis* suggests that *L. gibbicarina* is attracted by the odors emitted by the withering oil palm trees.

The entomopathogenic *Sporothrix insectorum* (Hyphomycete) was found controlling up to 98 % the lace wing bug *Leptopharsa hevae* in rubber plantations of Brazilian Amazonas. This fungus was introduced by INDUPALMA and IRHO in oil palm plantations in San Alberto (César, Colombia), to test its activity against *L. gibbicarina*. We compared this growth in different media and its pathogenecity.

The results obtained, in the field and at the laboratory, showed the great possibility of using *S. insectorum* to control *L. gibbicarina* in african oil palm plantations and perhaps Tingidae in other crops.

BACILLUS THURINGIENSIS AS AN EFFECTIVE CONTROL AGENT OF LEPIDOPTERAN PESTS IN TOMATO FIELDS IN ISRAEL. Meir Broza (Oranim, Haifa University, Tivon 36910, & Becker Microbial Products, Inc. Israel), Baruch Sneh (Institute for Nature Conservation Research, Tel Aviv University, Tel Aviv 69978, Israel).

The tomato looper, Chrysodeixes chalcites, which is a major pest of tomato, was controlled in a series of field applications with commercial product of Bacillus thuringiensis var. kurstaki (Bt). All larval instars, were susceptible to Bt. Therefore, timing of application, which has to be usually directed to hatching or young larvae, was not crucial to successful larval control of C. chalcites. The cotton bollworm, Heliothis armigera, usually accompanied the major pest at low to medium population densities (1-4 larvae/m. row). In 38 out of 40 commercial field (12-100 acres each) applications of Bt, both pests populations were suppressed to levels below the economic threshold, and were comparable to effective chemical pesticides. In tomato fields adjacent to potato fields, extensive damage is incited by the potato tuber moth Phthorimaea operculella. In an experimental trial, using back pack sprayer, three consecutive applications of Bt at a high volume (200 l/a) were required to control this pest.

Entomogenous Nematodes and Their Utilization in the Biological Control of Insect Pests

POST-APPLICATION BIOLOGY OF ENTOMOPATHOGENIC NEMATODES IN SOIL. J. Curran (CSIRO Division of Entomology, P.O. Box 1700, Canberra, ACT 2601, Australia)

Entomopathogenic nematodes can control insect pests in soil. To achieve control, large numbers of infective stage juveniles need to be inundatively released into soil at rates of 10^5 - 10^6 m^{-2}. Only a small proportion (e.g. 20-30% for *S. carpocapsae*) of these released nematodes are able to invade and kill insects at any given time. Moreover, as little as 10% of the initial inoculum is present in the soil 7 days post-application. Abiotic and biotic components of the soil environment influence nematode infectivity and persistence. However, recent evidence suggests that intrinsic genetic, physiological and behavioural characteristics of the infective stage juveniles also have a profound influence. These intrinsic factors may be amenable to manipulation, with the possibility that correct choice of nematode formulation, application technique and nematode species and strain can improve the infectivity and persistence of entomopathogenic nematodes in soil. This may permit lower application rates and thus open up a broader range of insects to economic control. It is recommended that persistence in soil should be included in screening programs for efficacy of entomopathogenic nematodes for control of soil insect pests.

TEMPERATURE RESPONSES OF ENTOMOPATHOGENIC NEMATODES: IMPLICATIONS FOR THE SUCCESS OF BIOCONTROL PROGRAMMES.

Christine T. Griffin (Department of Biology, St. Patrick's College, Maynooth, Co. Kildare, Ireland)

Temperature is an important factor limiting the success of field applications of steinernematid and heterorhabditid nematodes for the control of pest insects. Prospects for improved control at high and low temperatures are discussed. Strategies include the identification of pre-adapted wild types, selective breeding, and optimisation of pre-application conditions.

INTEGRATED CONTROL OF SOIL PESTS BY BENEFICIAL NEMATODES. Nobuyoshi ISHIBASHI (Department of Applied Biological Sciences, Saga University, Saga 840, Japan)

In field trials, an efficacy of Steinernema carpocapsae was enhanced by mixed application with insecticides. Being mixed with nematodes, oxamyl for the control of the turnip moth larvae in soil, fenitrothion and diazinon for the turfgrass insects, acephate and permethrin for the lepidopterous insects on cabbage plants, showed a better control of these pests than by an application with either nematodes or insecticides alone. Laboratory experiments showed that the insecticide treatments did not always increase the infectivity through stimulating the nematode to move, but did through activating nictation behavior.

Inundative release of S. carpocapsae into the soil with lower biological diversity, where its antagonists were chemically eliminated, suppressed a recovery of plant parasitic nematodes and effectively controlled invading soil insects.

A successful control of soil insect pests and plant-parasitic fungi will be also achieved by applying S. carpocapsae with the fungivorous nematode, Aphelenchus avenae; an application of A. avenae alone occasionally inhibited seed germination, but the inhibition was not induced by a mixed application of the two nematode species.

Microbial agents such as Bacillus thuringiensis and B. cereus were able to apply with the entomopathogenic nematodes. The mixed application of nematodes and bacteria brought about a more prompt death of insects than an application with the nematode alone.

BIOLOGICAL CONTROL OF SCARABS WITH ENTOMOPATHOGENIC NEMATODES. Michael G. Klein (USDA, Agricultural Research Service, Application Technology Research Unit, Wooster, Ohio 44691 USA)

Whitegrubs, the larvae of scarab beetles, are serious pests of turf, pastures, sugarcane, and horticultural crops throughout the world. Several nematode species (Steinernema glaseri, S. anomali, S. kushidai, and Heterorhabditis megidis) and strains of S. carpocapsae and H. bacteriophora have been isolated from whitegrubs, indicating their potential to control scarab larvae. Early efforts to colonize S. glaseri against the Japanese beetle failed, possibly due to a lack of appreciation for the nematode - bacteria complex. More recently, field efficacy with S. glaseri and H. bacteriophora has been demonstrated against a variety of whitegrubs. However, before reliable results can be expected, more information on overcoming host defense mechanisms is essential, application techniques which allow nematodes to successfully reach target pests must be developed, and the effects of biotic and abiotic factors on nematodes in the soil environment require elucidation. Prospects are increasing for the utilization of entomopathogenic nematodes as either inoculative or inundative agents for suppression of scarab larvae in the future.

SOIL BIOTIC FACTORS AFFECTING ENTOMOPATHOGENIC NEMATODES. Harry K. Kaya and Graham S. Thurston (Department of Nematology, University of California, Davis, California, 95616 USA)

Entomopathogenic nematodes are being applied as biological insecticides against a number of soil-inhabiting insect pests. One of several constraints in their use is that biotic factors affecting nematodes in the soil remain largely unknown.

Nematode-parasitic fungi, many of which parasitize the infective stage of entomopathogenic nematodes, are commonly found in soil. In soil infested with the fungus *Hirsutella rhossiliensis* (Hr), more *Steinernema glaseri* than *S. carpocapsae* or *Heterorhabditis bacteriophora* were infected by the fungus. Differences in fungal infection may be attributed to characteristics associated with the nematodes, including the presence of the second-stage (J2) cuticle and motility. *S. glaseri* easily loses its J2 cuticle and is motile. This nematode is more susceptible to Hr than *H. bacteriophora* which is prtected by the presence of the J2 cuticle, or *S. carpocapsae* which is a relatively immobile species.

Entomopathogenic nematodes are generally more successful in infecting an insect host than the entomopathogenic fungus *Beauveria bassiana* when both types of pathogens are placed in soil. Under such conditions the infective stage of heterorhabditid or steinernematid nematodes invades the insect host first and releases the symbiotic bacteria, *Xenorhabdus* species. The bacteria produce antibiotics and probably prevent the fungus from establishing in the insect cadaver.

CONTROL OF THE PEACH FRUIT MOTH, *CARPOSINA NIPPONENSIS* USING ENTOMOPATHOGENIC NEMATODES. Jin-xian Wang (Guangdong Entomological Institute, Guangzhou, China and currently CSIRO, Division of Entomology, Canberra, Australia)

Studies during the last decade on using entomopathogenic nematodes to control *Carposina nipponensis* , the most important pest of over 1 million hectares of apple, pear and date have indicated that nematodes could replace the currently used chemical insecticides. It has been found that *S. carpocapsae* is best applied to the soil surface beneath apple trees during summer rains which stimulate *Carposina* larvae to emerge from the deep over-wintering hibernacula and migrate to the surface to pupate. During this period, the larvae are most susceptible to nematodes and the soil ideal for nematode penetration. Field trials have been conducted in a variety of apple orchards in many provinces in China with larval mortality ranging from 91.8% to 98.4%; fruit damage indices and pheromone monitoring have indicated that control is better than with insecticides. During this collaborative project, under the auspices of the Australian Centre for International Agricultural Research, scientists from Guangdong Entomological Institute, the Biological Control Institute, CAAS in Beijing and the Division of Entomology, CSIRO, Australia, are also working together to develop efficient mass production and processing of *S. carpocapsae* on a pilot factory scale and to coordinate grower trials over hundreds of hectares of orchards throughout China.

AN IMPROVED SYSTEM FOR THE CONTROL OF THE BANANA WEEVIL BORER, *COSMOPOLITES SORDIDUS* WITH ENTOMOPATHOGENIC NEMATODES. N.L. Treverrow, (Wollongbar Agricultural Institute, NSW, Australia 2477) R.A.Bedding, (CSIRO Division of Entomology, Box 1700, Canberra, ACT, 2601)

A system for managing *Cosmopolites sordidus* populations using entomopathogenic nematodes introduced into bait holes made in residual banana corms has proved promising in large scale field trials. The BW strain of *Steinernema carpocapsae* was the most infective of 32 different strains and species of *Steinernema* and *Heterorhabditis* to adult *C.sordidus* and although 250,000 infective juveniles of this nematode were needed per bait hole to produce high levels of mortality in adults, such dosages are economically feasible and further artificial selection may continue to improve the BW strain. The use of entomopathogenic nematodes to control *C. sordidus* provides an alternative treatment at a time when increasing levels of resistance to organophosphate insecticides are being detected. It also avoids the potential for soil degradation associated with the use of conventional insecticides which involves the removal of old plant material from the base of the matt. The behaviour of the weevils in relation to these baits is of importance. To support the system, easily measured pest damage thresholds have been established at which nematode or other means of control should be implemented.

CURRENT STATUS OF THE BIOLOGICAL CONTROL OF *SIREX NOCTILIO* WITH THE NEMATODE *DELADENUS SIRICIDICOLA*. R.A. Bedding, (CSIRO Division of Entomology, Box 1700, Canberra, ACT 2601)

A recent outbreak of the woodwasp *Sirex noctilio* in the "Green Triangle" of Southern Australia where nematodes had not been adequately introduced resulted in up to 80% tree death in some areas of the 50,000 hectares of *Pinus radiata* plantations. The outbreak served as a "control block" to compare with other areas of plantation throughout Southern Australia which had had adequate nematode dispersal and usually insignificant tree mortality. It has been estimated that, if not controlled, over a 30 year rotation of Australia's 1 million hectares of pine, sirex has the potential to cause a $1-4 billion loss of timber. The nematode, *D.siricidicola* sterilises female sirex during its parasitic cycle but also has multiple free-living cycles in the tree while feeding on the symbiotic fungus. The fungal cycle enables unlimited *in vitro* culture of this nematode for biological control. Inadvertently, persistent use of this cycle has selected for a marked decline in infectivity which has resulted in reduced levels of parasitism in sirex both from timber inoculated for liberation programs and in sirex from the field. This situation is now being remedied following the re-isolation of the strain from where it was liberated 20 years ago.

Use of Facultative (Zoo-Phytophagous) Bugs in IPM

FEEDING HABITS OF MIRIDS: PESTS, PREDATORS AND OPPORTUNISTS. *A. G. Wheeler, Jr.* (Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, PA 17110--9408 USA)

The family Miridae is a large (nearly 10,000 species) and successful group. Much of this success relates to adaptations and modifications for overcoming the evolutionary hurdles of a life on green plants: desiccation, attachment, host defenses, and nourishment. As opportunists, mirids show great diversity in their feeding habits. They exploit nutrient-rich apical meristems, buds fruits, and mesophyll and other ground tissues of leaves and stems. Injury symptoms range from simple chlorosis and foliar shot-holing to lesions, cankers, and abnormal growth and differentiation (multiple stems, witches'brooming, stunting, etc.). Symptoms often closely resemble those induced by plant pathogens. Many species also are intimately associated with inflorescences, feeding on various floral parts and on nectar and pollen. Some are obligate predators of certain prey groups, e.g., thrips and lace bugs, and even pests may supplement their diet by becoming facultative predators and scavengers. On certain crops, a few species have been considered in the dual role of key pests and as key predators. researchers and crop management specialists sometimes do not appreciate the extent of carnivory (including cannibalism) in the family. The diet plasticity of mirids and potential for crop injure should be considered when mixed feeders (zoophytophages) are used in programs of integrated pest management (IPM).

IMPACT OF FACULTATIVE PLANT FEEDING ON THE LIFE-HISTORY OF A HETEROPTERAN PREDATOR. Robert N. Wiedenmann (Department of Entomology, Texas A&M University, College Station, Texas 77843 USA), Robert J. O'Neil and Jesusa C. Legaspi (Purdue University, West Lafayette, IN 47907 USA).

The generalist predator *Podisus maculiventris* maintains populations in several crop habitats, where it feeds on prey that occur at low densities. At low prey densities in soybeans, attack rates by *P. maculiventris* averaged 0.5 attacks per day -- equivalent to one attack every two days. We conducted laboratory experiments to determine how the low prey inputs measured in the field influenced the life history of the predator. Predators were provided individual prey meals at increasing time intervals, but had continuous access to plant material. Results showed that predator survival was not influenced by increasing intervals between prey, but the number of eggs produced decreased with increasing intervals between meals. Predators fed fed only plant material did not survive as long as predators fed one prey meal the first day as an adult, then only plant material over the remaining lifetime, nor as long as predators fed prey throughout the lifetime. Predators in both plant-feeding treatments did not produce any eggs. The pattern of survival and reproduction indicates that supplementing infrequent prey meals by facultative phytophagy is important to *P. maculiventris*, providing nutrition that enhances survival until prey are available. Although a phytophagous diet allows the predator to survive, it is not sufficient for the predator to produce offspring. The results may reflect a currently predaceous species with a phytophagous ancestry, that is adapted to survive long periods without prey by plant-feeding, but still requires prey for reproduction.

MANAGEMENT OF THE MULLEIN BUG, CAMPYLOMMA VERBASCI (HETEROPTERA:MIRIDAE), IN POME FRUIT ORCHARDS OF CANADA. H.M.A. Thistlewood (Agriculture Canada, Research Station, Vineland Station, Ontario L0R 2E0, Canada) and R.F. Smith (Agriculture Canada, Research Station, Kentville, Nova Scotia B4N 1J5, Canada)

The mullein bug is the most significant of the few mirid bugs which are both predaceous and phytophagous in Canadian fruit crops. The history of this introduced species in Canada is reviewed, and its roles as a predator and a pest on pome fruits are compared. Management of this insect has been improved by consideration of host-plant associations, use of a temperature accumulation model, sequential sampling plans, damage thresholds, and employment of its sex pheromone. The integration of these and other tools in IPM programs is discussed.

PREDATORY MIRIDS IN APPLE ORCHARDS IN QUEBEC. Guy Boivin (Research Station, Agriculture Canada, St-Jean-sur-Richelieu, Québec, Canada J3B 3E6).

The predatory mirids of five pests were studied in an apple orchard in Québec, Canada. The tarnished plant bug, *Lygus lineolaris*, was attacked by no mirid species but the green apple bug, *Lygocoris communis* had one mirid predator, *Deraeocoris fasciolus*. The green apple aphid, *Aphis pomi*, was attacked by all mirid species tested and *D. fasciolus* and *Lepidopsallus minisculus* consumed 7-9 aphids per day. The mirid *Hyaliodes vitripennis* consumed 26 two-spotted spider mite, *Tetranychus urticae* and 18 European red mite, *Panonychus ulmi*, per day. The polyphagy of these species and the lack of data on their functional and numerical responses preclude a definite conclusion on their efficiency as biological control agents.

COMPONENTS OF A VARIABLE SPRAYING THRESHOLD FOR APPLE DIMPLING BUG, *CAMPYLOMMA LIEBKNECHTI* GIRAULT, ON APPLE. Colin C. Bower, H.I. Nicol (Agricultural Research and Veterinary Centre, Forest Road, Orange, NSW 2800 Australia), B.J. Valentine (Anderson Valentine and Associates, 196 Lords Place, Orange, NSW 2800 Australia)

Apple dimpling bug, *Campylomma liebknechti* Girault invades orchards in bloom from surrounding vegetation and feeds on the ovaries causing dimple-like depressions and russet to develop on the fruit. However, *C. liebknechti* is also an effective predator of mites post-bloom. Data from a five year study on Granny Smith apples showed a linear relationship between cumulative bug activity (bugdays) during flowering and downgrading of fruit at harvest. Economic thresholds for sprays of fluvalinate and endosulfan were determined from a spreadsheet model of the costs and returns for a typical NSW apple orchard. For fluvalinate the economic threshold was 22 bugdays per 50 inflorescences, which causes one percent downgrading of the crop. The corresponding figures for endosulfan were 7.3 bugdays or 0.3 percent downgrading. A variable spraying threshold, based on the concept that damage is a product of both bug numbers and the length of time bugs are in the flowers, is proposed. The variable threshold tolerates larger bug populations towards the end of bloom when there is less time for damage to occur. The spraying threshold is also adjusted to account for variation in the susceptibility of buds, flowers and fruitlets at different phenological stages. Most damage occurs in the period from pink bud to full bloom.

STRATEGY OF USE OF THE PREDACEOUS BUG, Macrolophus caliginosus W. (Heteroptera, Miridae) IN GLASSHOUSE CROPS. Malausa J.C. (Institut National de la Recherche Agronomique, Laboratoire de Biologie des Invertébrés, 1382 Route de Biot F-06560 Valbonne - France).

On the south of France, several species of mirid bugs of the sub-family Dicyphinae appeared as important predators of major pests in protected crops. Among them, Macrolophus caliginosus WAGNER is the only one which don't cause any damage to the plant. After to have determine the main biological characteristics of this species, we studied the possibilities to rear and to keep it with the aim to increase the availability of beneficial arthropods for integrated control on glasshouses crops.

Since several years, trials on experimental and commercial greenhouses were done to define a strategy of use of these predators (period, density and development stages for releases) as part of the biological control against the greenhouse whitefly Trialeurodes vaporariorum WESTWOOD on winter tomato crops.

MANAGEMENT OF THE FACULTATIVE PREDATOR *DICYPHUS TAMANINII* WAGNER IN FIELD TOMATOES. O. Alomar (IRTA, Centre de Cabrils, 08348 Cabrils, Barcelona, Spain), R. Albajes (UPC-IRTA, Rovira Roure 166, 25006 Lleida, Spain)

Dicyphus tamaninii Wagner and *Macrolophus caliginosus* Wagner (Het.: Miridae) are two native generalist predatory bugs being successfully used for greenhouse whitefly (*Trialeurodes vaporariorum* Westwood) management in outdoor tomato crops in Catalonia, Spain. However *D. tamaninii* is also phytophagous and occasionally feeds on tomato fruits. Damage to fruits can be related to a shortage of alternative insect prey. This hypothesis was the basis for a Decision-chart which allows the conservation of *D. tamaninii* up to a level where it may excessively control whitefly and start damaging the fruit. Here we report on the results of a three-year evaluation of the Decision-chart.

Applications of genetics in studies on parasitoids and predators. T.R. Unruh (USDA-ARS, 3706 W Nob Hill, Yakima, Washingtion USA 98902).

Genetic attributes of parasites and predators have been little used as resources in biological control. Early emphasis on sampling populations from central and marginal distributions of populations have shed little light on how best to sample natural enemies, however, modern enzyme and DNA techniques allow detailed analyses of population structure which can point to optimal strategies for parasite selection and maintenance. To date these techniques have been used in pseudo-systematic studies of parasitic Hymenoptera and these are reviewed. Examples of how more detailed description can foster importation choices are also discussed. Peculiar attributes of reproductive biology and endosymbiosis in some parasitic wasps represent new avenues for genetic improvement. Simple procedures based on knowledge of these systems may also be used to increase success rates in classical biological control.

GENETICS OF BIOLOGICAL CONTROL INTRODUCTIONS. K. R. Hopper (European Biological Control Laboratory, Agricultural Research Service, United States Department of Agriculture, BP 4168, 34092 Montpellier Cedex 5, France), R. T. Roush (Entomology Department, Cornell University, Ithaca, New York 14853, USA), W. Powell (Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ, UK)

The importance of genetics and the possibility of genetic manipulations in biological control have been debated for over 60 years. We review the evidence in the literature concerning levels of genetic variation in traits likely to affect establishment and pest control by introduced natural enemies. We concentrate on three topics: (a) Are there genetic barriers to using a natural enemy that attacks one species for control of another species? If so, how can these barriers be overcome? (b) Does laboratory rearing cause genetic maladaptation in the field? If so, how can such maladaptation be avoided, (c) Is genetic adaptation after introduction important for establishment and/or control? If so, how can such adaptation be promoted. Although there is some evidence for genetic barriers to using a natural enemy from one species against another species, the barriers are weak and can be overcome in a few generations. The evidence for laboratory rearing causing genetic maladaptation in the field is weak. Furthermore, there are methods for preventing selection for laboratory-adapted biotypes. Despite the popularity of the idea of adaptation after introduction, there are few documented examples and little information and much controversy about how such adaptation can be promoted. Demography and diseases may prove to be larger barriers to establishment and/or control than lack of genetic adaptation. We recommend methods for managing the genetics of introductions, and we suggest areas where research is needed to fill gaps in these data.

GENETICS OF PARASITIC HYMENOPTERA. Robin E. Owen (Dept. of Chem. & Biol. Sci., Mount Royal College, Calgary, T3E 6K6 and Dept. of Biol. Sci., University of Calgary, Calgary, T2N 1N4,Alberta, Canada).

Parasitoid Hymenoptera have a haplodiploid genetic system in which (diploid) females arise from fertilized eggs, and males usually arise from unfertilized eggs and are haploid. The peculiarities of this system may help or hinder introduction of parasitoids as control species:(1) Smaller effective population size and efficacy of selection in haplodiploids (as compared to diploids) probably accounts for the observed low degree of heterozygosity. There may be limited response to selection, but effects of inbreeding may not be severe.(2) Introduction of small numbers of parasitoids may lead to "bottlenecking" of sex-determination alleles leading to an increase in diploid male production in species with a small number of sex-determining loci.(3) Female biased sex ratios result from local mate competion; population structure could be manipulated to yield a sex ratio advantageous for control.(4) Sexual differentiation in response to ecological conditions occurs due to the behavioral differences between the sexes.(5) The rate of transmission of extranuclearly inherited traits, as seen in *Nasonia* and *Muscidifurax*, is enhanced by haplodiploidy.

INCREASING GENOME DIVERSITY FOR RELEASE OF PARASITES AND PREDATORS. Bennett, Fred. D. (Entomology and Nematology Department, University of Florida,P.O.Box 110620, Blg.970. Gainesville, Fl.32611, USA)

The goal of classical biological control is the field release of effective biotic agents for the permanent suppression of the target pest without causing any adverse impact to the ecosystem. The standard biological control protocol includes exploration, host range testing and quarantine screening. Often only a small proportion of the genome diversity present in the area of origin is represented in the final laboratory colony at the time of field release. This may account for the failure of establishment or explain why certain control agents are only partially succesful. Examples, mainly from the Neotropics, where attempts to increase genome diversity have given positive results are presented.

MAINTAINING GENETIC DIVERSITY IN LABORATORY COLONIES OF PARASITES AND PREDATORS. Alan C. Bartlett (Western Cotton Research Laboratory, USDA, ARS, 4135 E. Broadway, Phoenix, Arizona 85040.)

The use of predators and parasites in biological control programs or experimentation requires large numbers of individuals that function in the native environment similar to their native relatives. An important factor that may decline during the process of laboratory domestication is the level of genetic variation in the colonized population. Without genetic variability, populations cannot adapt to the changing environments they may encounter in the native habitat. The following elements must be considered in the establishment and maintenance of colonies of predators and parasites: 1) the effect of sampling from the large feral population; 2) the effect of natural selection under laboratory conditions; 3) the effect of mating system; 4) the effect of genetic recombination; and 5) the effect of mutation. Our ability to control or minimize the effects of each of these elements will affect the ability of colonized species to interact with native populations of pest species. Manipulation of the genetic parameters necessary to achieve such control will be discussed.

GENETICS OF BIOTYPES, William W. M. Steiner (USDA-ARS Biological Control of Insects Res. Lab. Univ. of Mo. Research Park, Columbia, MO 65205, USA)

The identification of insect biotypes, if not a concept which has been questioned outright, has at the least always been a problem. Examples of some of the older or more classical approaches are easy to see, some of which have important implications for human health or agricultural economies. Newer techniques, including genetic ones, have been applied to some of these problems, and clearly demonstrate their validity. A discussion of the examples, techniques, possible misinterpretations and other problems is presented.

SELECTION FOR PESTICIDE RESISTANCE IN NATURAL ENEMIES: AN OVERVIEW. Marshall W. Johnson & Bruce E. Tabashnik (Department of Entomology, University of Hawaii at Manoa, Honolulu, Hawaii 96822, U.S.A.)

Several predatory arthropod species have undergone laboratory selection for increased pesticide resistance. Phytoseiid mite species among this group include *Phytoseiulus persimilis* Athias-Henriot, *Amblyseius fallacis* (Garman), *Amblyseius nicholsi* Ehara and Lee and *Metaseiulus occidentalis* (Nesbitt). Probably the most successful results of laboratory selection have occurred in *M. occidentalis*. This species has been selected for resistance to carbaryl, methomyl, dimethoate, permethrin, and fenvalerate. Selected strains of *M. occidentalis* are now commercially produced for mass releases in almond and apple orchards resulting in substantial economic benefits to California agriculture. An insect predator, the common green lacewing, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), has also been selected for carbaryl resistance.

Studies conducted using parasitoids in selection programs have had limited success. Several attempts have been made to artificially generate resistant parasitoids. Selection conducted on colonies established from field populations of *Aphytis melinus* DeBach, a parasitoid of the California red scale, exhibiting low levels of resistance to various insecticides produced a parasitoid strain ca. 20 times more resistant to carbaryl than a standard susceptible colony. Using laboratory selection, levels of azinphosmethyl resistance were increased 7.5-fold in *Trioxys pallidus* Haliday which parasitizes the walnut aphid, *Chromaphis juglandicola* Kaltenbach, in walnut orchards. Although azinphosmethyl resistance was significantly increased, bioassays suggested that the selected *T. pallidus* strain could not survive rates of azinphosmethyl applied in the field. Laboratory studies showed that the selected azinphosmethyl-resistant *T. pallidus* strain exhibited cross-resistance to residues of chlorpyrifos, endosulfan , methidathion, and phosalone. Experimental field studies showed that the azinphosmethyl-resistant *T. pallidus* strain could establish and persist in walnut orchards receiving 1 to 2 applications of azinphosmethyl and methidathion.

GENETIC ANALYSIS OF THE RESISTANCE OF TWO STRAINS OF PREDATORY MITES TO SYNTHETIC PYRETHROID INSECTICIDES. N.P. Markwick (DSIR Plant Protection, Private Bag, Auckland, New Zealand).

Two strains of the beneficial predatory mite, Typhlodromus pyri Scheuten, which are resistant to synthetic pyrethroid (SP) insecticides, have been bred in New Zealand under laboratory and field selection programmes. Genetic analysis of the inheritance of the SP-resistance in each strain was undertaken by crossing the resistant strains with a susceptible field-collected strain and with each other. Results showed there are no maternal effects involved in the inheritance of the resistance which is incompletely dominant. Crosses between laboratory and field selected resistant strains indicated that the inheritance of the SP-resistance was probably controlled by a similar genetic mechanism in both strains but did not clearly show whether this was polygenic or single gene.

BIOLOGY, HOST PREFERENCE, NATURAL ENEMIES AND TRAP CROPPING OF CRUCIFER PESTS ON GUAM. P. Singh, R. Muniappan and M. Marutani. (College of Agriculture and Life Sciences, University of Guam, Mangilao, Guam 96923 U.S.A.).

Biology of Crocidolimia pavonana and Hellula undalis were studied in the laboratory. Host preference of adult moths in laying eggs and the larval feeding of C. pavonana and H. undalis were determined. An egg parasite Trichogramma sp has been recorded on the eggs of Plutella xylostella from the Mariana Islands. Trap cropping system using mustard, Chinese cabbage cv. Tempest and radish grown in the head cabbage has been giving satisfactory results in control of H. undalis, C. pavonana, Halticus tibialis and Lipaphis erysimi.

SENSITIVITY OF COTESIA PLUTELLAE AND DIADEGMA SEMICLAUSUM, PARASITOIDS OF DIAMONDBACK MOTH (PLUTELLA XYLOSTELLA L.), TO SEVERAL INSECTICIDES

Morallo-Rejesus, B.*, J.B. Obra** and F.V. Salazar**
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The toxicity of several types of insecticides (deltamethrin, fenvalerate, metamidophos, malathion, carbaryl, cartap and Bacillus thuringiensis var kurstaki) to adults of Cotesia plutellae and Diadegma semiclausum were determined by residual film method. Three fungicides were evaluated on Cotesia.

Based on LC_{50} and LC_{95}, malathion, metamidophos, cartap and deltamethrin among the insecticides tested were found toxic to both parasitoids, while fenvalerate, carbaryl and B. t. var kurstaki were relatively non-toxic. The fungicides (copper oxychloride, chlorothalonil and mancozeb) were not toxic to Cotesia.

Effect of these selective insecticides on parasitization was determined. Cabbage plant was sprayed with Cotesia and DBM (direct exposure) or Cotesia was introduced after spraying the plant with DBM (indirect exposure). Sprayings did not affect the adult Cotesia. B. t. var kurstaki caused very high mortality of DBM which caused the very low percentage parasitism. Fenvalerate and carbaryl although ineffective against DBM larvae (resistant) did not affect parasitization and adult emergence of Cotesia.

SOME ECOLOGICAL ASPECTS OF PLUTELLA BIOLOGICAL CONTROL, WITH EMPHASIS ON LOWLAND SYSTEMS.

Jeff Waage (International Institute of Biological Control, Ascot, Berks SL5 7TA, UK.)

Classical biological control of tropical *Plutella xylostella* populations has involved, since 1935, the introduction and redistribution of parasitoids which come originally from cool temperate regions. The hypothesis that this has affected their performance in tropical lowlands is discussed, and a programme of exploration and research presented for improving control in hotter climates.

BIOLOGICAL CONTROL OF DIAMONDBACK MOTH: A COLLABORATIVE APPROACH IN ASIA. N. S. Talekar (Asian Vegetable Research and Development Center, AVRDC), P.O. Box 42, Shanhua, Tainan 74199, Taiwan, China.

Diamondback moth (DBM), *Plutella xylostella* (L.) is the most important pest of all economically important crucifers in Asia. Intensive use of insecticides has resulted in this insect becoming resistant to practically all of them. This control practice has also reduced the beneficial effects of parasites and predators. A collaborative research network has been set up in ten countries in Asia, with financial support from the Asian Development Bank, to introduce the larval parasites *Diadegma semiclausum* Hellen and *Cotesia plutellae* Kurdjumov, and a pupal parasite *Diadromus collaris* (Gravenhorst) to combat DBM in areas where these natural enemies do not occur. *Diadegma semiclausum*, which has already been established in the highlands of Indonesia and Malaysia, is now also established in similar areas of Taiwan and the Philippines. *Diadromus collaris* is established in the highlands of Malaysia and Taiwan and is being introduced in similar areas of the Philippines and Indonesia. These two parasites can adequately control DBM in the highlands. *Cotesia plutellae* occurs in lowland areas of all Southeast Asian countries, except Indonesia, where it is being introduced. This parasite alone does not give adequate control of DBM, so there is a need to search for and introduce high temperature-tolerant larval or pupal parasites in the lowlands. Inundative releases of *Trichogrammatoidea bactrae* Nagaraja are made to supplement DBM control achieved by *C. plutellae* in the lowlands.

DIAPAUSE IN THE COTESIA PLUTELLAE (HYMENOPETARA: BRACONIDAE), A LARVAL PARASITOID OF THE DIAMONDBACK MOTH). S.M. Alvi , and S.Momoi (Entomology Laboratory, Kobe University, Kobe 657 Japan)

Cotesia plutellae (Northern population of Japan) has a facultative diapause in the last instar larva(prepupa) within its cocoon. Diapause is initiated by short daylengths during the development of the parasite larva in the body of the host. Temperature influenced the photoperiod mediated diapause response as the diapause incidence decreased at 20° C and no diapause could be induced at 25 °C. The second and third instar larva must experience the shortday for diapause to occur; however, egg and first instar larva appear to have no role in diapause induction. At 17 °C, when daylengths decreased from 12.5 hours diapause incidence increased from 69 to 100 percent whereas under LD 13:11 no diapause resulted. Duration of diapause depends on the temperature at which the diapausing cocoons are maintained, with photoperiod being unimportant. Higher temperatures hastend the termination of diapause and emergence occured within shortest time (21.0 day) at 25 °C within the temperature range (15 °C to 25 °C) tested.

LIMITATION ON THE BIOLOGICAL CONTROL OF DIAMONDBACK MOTH IN BACAU COUNTY, ROMANIA. *Mustata Gheorghe* (Univ."AL.I. Cuza" Jassy, Romania)

We present in the paper, the contribution of the parasitoid species to the limitation of *Plutella xylostella* (L.) populations from cabbage crops of some localities in the Bacau country.

A complex of over 15 species of parasitoids from the *Ichneumonidae* and *braconidae* families realizes a limitation of over 75%.

On the basis of synecological analysis, it is shown the contribution of each species to the limitation of host populations. It is also mentioned the species which have the main role in the limitation of *Plutella xylostella* populations, being necessary, in the conditions of Romania, only their protection, that is the avoidance of the reduction of their populations by unrational utilization of pesticides.

ATTEMPTS TO CONTROL THE DIAMONDBACK MOTH IN JAPAN BY TRICHOGRAMMA. O. Mochida, A. Kikuchi (Natl Agric Res Centre, Ibaraki-ken, Tukuba-si, Kan'nondai, 305 JAPAN), H. Nakazawa, & S. Kobayashi (Nagano Vegetable & Ornamental Crops Expt Sta., Nagano-Ken, Suzaka-si, 381-12 JAPAN)

Mamestra brassicae as an alternative host was reared by two artificial diets. One for 1st- to 3rd-instars consisted of kidney bean (Phaseolus vulgaris), RC4 (feed for rabbits/marmottes, Oriental Yeast Co.), vitamines, and some minor components. The other for older than 3rd-instars did of kidneybean, wheat bran, dry yeast, and some minor components. Though mortality of larvae and/or pupae fluctuated time to time, about 730 normal adults were obtained from 1,000 eggs. Avg number of eggs laid /5 pairs was 8,157 (ranging 3,765-16,078). Avg longevity in paired male and female was 6.7 (3-17) and 8.1 (1-13) days, respectively, when kept at 25°C with 10% honey-water sol. Eggs laid on paper were sterilized within 24hrs after egg deposition at about 900 $\mu w/cm^2/nm$ by a 15W ultraviolet fluorescent tube (GL-15, Toshiba Electric Co.). Such irradiated eggs were available for Trichogramma parasitization for more than one month when kept at 5°C. T. chilonis adults were released on such irradiated eggs of M. brassicae at 25°C for 24 hrs. The developmental period from egg deposition to adult emergence in T. chilonis was 82-94, 61-62, 28-29, 15, 8, and 6 days at 7, 11, 15, 18, 25 and 28-33°C, respectively. Number of adult parasitoids from one host egg was 2.7 on an avg. Male: female ratio was 88.7 : 100. Trichogramma was released in cabbage fields in Nagano and suppressed DBM populations sufficiently.

BIOLOGICAL CONTROL OF Plutella xylostella IN INDONESIA. Sastrosiswojo, S., Lembang Horticultural Research Institute, Jl. Tangkuban Parahu 517 Lembang, Bandung 40391, Indonesia.

Diamondback moth (DBM), Plutella xylostella (L.), is a major pest of crucifers and widely distributed in Indonesia. Diadegma semiclausum was introduced from New Zealand in 1950 to control DBM in the highland areas, while Cotesia plutellae was introduced from AVRDC (Taiwan) and MARDI (Malaysia) in the late 1980s to control DBM in the warmer areas (mid-/lowland areas). Parasitoid releases were combined with the use of Bacillus thuringiensis. Currently, D. semiclausum is well established and widely distributed in almost all over Indonesia, while C. plutellae was not entirely established in the warmer areas. In the highland areas, D. semiclausum has became a key component of IPM on DBM. The strategy in managing DBM in the highland areas is to increase the role of D. semiclausum as a biological control agent of DBM by the use of selective insecticide when the population of DBM surpasses its control threshold (0.5 caterpillar/plant). Effort to develop biological control of DBM in the warmer areas by using C. plutellae is still being undertaken.

Population trends of diamondback moth parasitoids in cabbage fields under different pest control regimes

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The population trends and abundance of parasitoids of the diamondback moth, Plutella xylostella were examined on cabbages treated prophylactically (weekly) with insecticides and those which involved three Integrated Pest Management (IPM) packages. In the highlands (> 915-1525 m above sea level), the larval endoparasitoids, Diadegma semiclausum and Cotesia plutellae were the main parasitoids in all treatments. The population of the pupal parasitoid, Diadromus collaris was low. In the lowlands, C. plutellae was the sole parasitoid species. In both locations, peak parasitoid populations usually occurred towards the end of the crop. There were indications that D. semiclausum had displaced C. plutellae as the major parasitoid in many locations in the highlands. In the lowlands, C. plutellae populations showed numerical response to the host larval populations. The relatively higher parasitoid-host ratios obtained, in general, in the prophylactically-treated cabbages compared to those on IPM cabbages, suggested that C. plutellae showed some degree of tolerance to insecticides despite the latter's intensive use.

STUDIES ON AN ENTOMOPATHOGENIC FUNGUS, ZOOPHTHORA RADICANS, FOUND ATTACKING PLUTELLA XYLOSTELLA IN FLORIDA, U.S.A.
Nuessly, Gregg S. (Department of Entomology), L. Datnoff (Department of Plant Pathology)(University of Florida, Everglades Research & Education Center, P.O.Box 8003, Belle Glade, FL 33430, USA)

An entomopathogenic fungi attacking Plutella xylostella reached epizootic proportions in Florida in Spring 1991. Field incidence on individual plants reached 100% (n=12 to 140 infected hosts/plant). The fungus was determined to be Zoophthora radicans. The south Florida isolate of the fungus kills second through fourth larval instars, pupae, and adult P. xylostella. Larvae stop feeding within 2 d of infection. Eruption of the fungus through the cuticle and production of conidia occurs within 5 d of infection. Initial tests indicated that the fungus is specific to P. xylostella. More extensive tests of host range of the fungus will be presented. Fungal biology and range of environmental conditions necessary for laboratory culture and field infection will be presented.

APPROACHES TO ENHANCE BIOLOGICAL CONTROL WITH PARASITOIDS FOR IPM OF DIAMONDBACK MOTH IN CRUCIFERS

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Population trends of the parasitoids in Integrated Pest Management (IPM) trials exhibited numerical response to host larval populations. However, peak parasitoid populations usually occurred towards the end of the crop. Considering the ephemerality of crucifers, such asynchrony of parasitoids to their hosts may render them ineffective. To enhance the action of parasitoids in the DBM-IPM program three approaches were considered. First, five parasitoid production centers were set up to mass rear parasitoids for inoculative or inundative releases. Such releases were timed during the early stages of the crop. Secondly, to prime or orientate mass released parasitoids into a 'find and attack' mode, behavioral manipulation using kairomones has been found to be useful. This is illustrated using Cotesia plutellae as a model. The third approach involved enhancing the complexity of the agroecosystem with plants that help sustain parasitoids. For example, Crotolaria striata, intercropped with cabbages, was found to reduce the incidence of DBM damage. Laboratory results showed that C. plutellae fed with C. striata nectar lived significantly longer and had higher fecundity than those fed with water only.

INFLUENCE OF SUBLETHAL DOSES OF INSECTICIDES ON THE POPULATION SYSTEMS OF *PLUTELLA XYLOSTELLA* AND ITS PARASITOID *DIADEGMA EUCEROPHAGA*.
Gu Dejiu(Lab. of Insect Ecology,South China Agricultural University, Guangzhou, 510642, China), Wright D. J. (Imperial College, Silwood Park,U.K.), Waage J. K.(International Inst. Biol. Control, U.K.)

A study on effect on sublethal doses of insecticides on the population systems of *Plutella xylostella* and its parasitoid *Diadegma eucerophaga* was carried out both in laboratory and field in Silwood Park, U.K., in 1990-1991. The insecticide 20PPM of sypermethrin and 25PPM of Nomolt(teflubenzuron), life table technique and systematic analysis were used. The control efficiency(CE) was introduced to evaluate the effect of Nomolt, Nomolt+*Diadegma* and *Diadegma* on diamondback moth separately were 56.89%,68.81% and 72.27% respectively in simulated system(in laboratory) . The CEs of Nomolt and cypermethrin on diamondback moth in field were also demonstrated. It was found that parasitism of *Diadegma* on diamondback moth in treatment of Nomolt was lower significantly than in untreated,but not different significantly than in the treatment of cypermethrin. For some insecticides like IGRs, systematic analysis and life table analysis may be the best way to examine insecticide sublethal effects on the population system of natural enemies.

ADVERSE EFFECT OF FACULTATIVE HYPERPARASITOIDS ON BIOLOGICAL CONTROL OF THE CHESTNUT GALL WASP. Yôzô Murakami (Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan),Yutaka Gyoutoku (Fruit Tree Research Institute, Kumamoto Agricultural Research Center, Matsubase, Kumamoto 869-05, Japan)

Torymus sinensis Kamijo (Torymidae) imported from China was released in a chestnut orchard in Kumamoto in 1982, and has been established there. However, the parasitism of the chestnut gall wasp, Dryocosmus kuriphilus Yasumatsu (Cynipidae) by the parasitoid remains low, and the cynipid density is high even at 9 years after release. In order to determine the reasons, a possible detrimental effect of the native hyperparasitoids was investigated at the experimental orchard. As a result, it was concluded that the parasitoid would suffer a high mortality during mature larval stage by parasitization by several facultative hyperparasitoids such as an undetermined Eupelmus sp. (Eupelmidae), Eupelmus urozonus Dalman (Eupelmidae) and Eurytoma setigera Mayr (Eurytomidae).

SOME STUDIES ON *PROSPALTELLA BERLESSEI* IN BIOLOGICAL CONTROL ON *PSEUDAULACASPIS PENTAGONA* IN GUILAN PROVINCE. A. Habibian (Plant pests and Diseases research Department, P.O. Box 133, Anzaly, Iran).

Our investigation showed that the vasp parasite of mulberry scale begins to develope with laying its eggs on second nymphal instar of pest, and emerges as adult from the exit hole on third nymphal instar. Each wasp lays about 25 eggs and maximum period of oviposition in 25° is recorded about 3 days. Exposure to low temperatures of 0° to -5°C can give high mortality of adults, larvae and pupae, in natural conditions in temperature of 0° and -2°C population density has been decreased from 60 to 24 adult on 5 cm^2 of mulberry branch. Parasitism in a condition with using of light was more than other hosts, such as potato or pumpkin according to rearing the mulberry scale on these three hosts. Also parasitism on second nymphal instar is more than on third instar if we release the wasp on these two instars separately. At least, parasitism under natural condition has been recorded about 30 percent.

NATURAL POPULATION AND HOST PREFERENCE OF THREE IMPORTANT ENCYRTID PARASITOIDS ATTACKING COCCOIDS ON GUAVA IN CHITTAGONG, BANGLADESH : A FOCUS ON BIOLOGICAL CONTROL. Badrul Amin Bhuiya, Shafique Haider Chowdhury (Department of Zoology, University of Chittagong, Chittagong 4331, Bangladesh), S. M. Humayun Kabir (Department of Zoology, University of Dhaka, Dhaka 1000, Bangladesh).

The population of *Ferrisia virgata* (Cockerell), *Planococcus pacificus*(Cox),*Rastrococcus invadens* Williams, and *Phenacoccus* sp. (Homoptera : Pseudococcidae) in a guava (*Psidium guajava)* orchard in Chittagong, Bangladesh, were screened at fortnightly intervals for three years to determine the rate of parasitism by *Aenasius advena* Compere, *Blepyrus insularis* Cameron, and *Anagyrus mangicola* Noyes (Hymenoptera:Encyrtidae). Most preferred host for *A. advena* and *B. insularis* was *F. virgata*. *P. pacificus* were parasitized only when the former were absent or very few in number. *A. mangicola* preferred *P. pacificus* in nature. The three other coccoids, namely *F. virgata*, *R. invadens* and *Phenacoccus* sp. were used as alternate hosts by this parasitoid during scarcity of the primary hosts.

MATING AND OVIPOSITION IN THREE ENCARSIA SPECIES, PARASITOIDS OF WHITEFLIES IN JAPAN. Hiroshi Kajita (Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Two native species, Encarsia japonica Viggiani and E. transvena (Timberlake), and an introduced species, E. formosa Gahan, have been commonly reared from the greenhouse whitefly, Trialeurodes vaporariorum (Westwood), and the tobacco whitefly, Bemisia tabaci (Gennadius), in Japan. Mating behavior of E. japonica and E. transvena differed from that of E. formosa: the male of the former two species mounted the female before and after copulation, while the male of the latter did not. When the postcopulatory courtship of the former two species was interrupted, most males failed to fertilize eggs. E. japonica and E. transvena, which are arrhenotokous, laid fertilized female-producing eggs in healthy whiteflies, and unfertilized male-producing eggs on fully-grown larvae or pupae of their own species or of closely related species in whitefly pupae. The thelytokous parasitoid, E. formosa, laid both male- and female-producing eggs in healthy whiteflies. Male occurrence of E. formosa was induced by treatment with tetracycline hydrochloride, indicating that symbionts may affect the mode of reproduction.

INTRA- AND INTERSPECIFIC HOST DISCRIMINATION AMONG THREE EGG PARASITIODS OF LITCHI STINK BUG.
Yu-qing Tang, Qi-yuan Lin, Mei-xiang Wu (Biological Control Research Institute, Fujian Agricultural College, Fuzhou, Fujian, 350002, China)

The intra- and interspecific host discrimiation among 3 egg parasitoids, Anastatus japonicus Ashmead, Anastatus sp. and Ooencyrtus sp., which attack eggs of the litchi stink bug Tessaratoma papillosa Drury, was determined in laboratory studies. Both Anastatus japonicus and Anastatus sp. were able to distinguish directly between conspecifically and heterospecifically parasitized host eggs as well as between self and conspecifically parasitized host eggs on the basis of external post-ovipositional host markings. These host markings could last more than 10 days, but there was difference in frequency of host acceptance with hosts parasitized over varying periods. Ooencyrtus sp. had no ability to detect host eggs that were previously parasitized by conspecific female and it laid as about twice eggs in previously parasitized host($\bar{X}$=9.2) as in previously unparasitized host($\bar{X}$=4.7). There was no interspecific host discrimination between Ooencyrtus sp. and Anastatus spp.. The host acceptance behaviors of 3 parasitoids were obversed and recorded in detail. The effectiveness of these parasitoids in biological control of litchi stink bug was also discussed on the basis of their different foraging behaviors.

BIOLOGICAL CONTROL OF GEMIBERLESIA PITYSOPHILA (HOM.:DIASPIDIDAE) BY COCCOBUS AZUMAI (HYM.:APHELINIDAE), A PARASITOID INTRODUCED FROM JAPAN. Wuyue Pan, Goulin Xie, Decheng Ding (Forestry Dep. of Guangdong Prov. Guangzhou 510173, China)

H. pityspohila, originally distributed in Okinawa and Taiwan, was accidentally introduced into Guangdong, China at the early of 1980's, and did extremely harm to the P. massonian trees there. After some biological and behavioral studies of the parasitoid, C. azumai, introduced from Okinawa into Huidong, Guangdong in 1987, was investigated, it was first released in June, 1989 in the massonian pine trees against H. pityspohila and great success was achieved.

The test showed that releasing 300 females at one point would spread to an area of 10ha after one year. At the positions 30 and 150m away from the release site, the parasitism rates were 47.2, 2.3% and the mean numbers of female scale were 0.72, 1.57 per leaf respectively. After two years, the parasitism rate at the later position also increased to 54.6% and the density of host declined for more than 10.0 times.

BIOLOGICAL CONTROL OF THE FILBERT APHID USING *Trioxys pallidus*: A SUCCESS STORY. M. T. AliNiazee, (Dept. of Entomology, Oregon State University, Corvallis OR 97331-2907 U.S.A.)

Studies on biological control of the filbert aphid, *Myzocallis coryli* using *Tripxys pallidus* were initiated during 1984-85 year. Successful foreign exploration in Europe, importation to U.S.A., and releases in Oregon were accomplished during the initial phases of the program. Establishment of *T. pallidus* occurred within a two year period in many hazelnut orchards. Recent data on parasite dispersal, efficacy and insecticide tolerance suggest that *T. pallidus* has done extremely well in all these three areas. An economic analysis of the project showed a substantial amount of savings to the hazelnut growers of the northwestern U.S.A. due to biological control of filbert aphid. Both from the biological and economic view points, this has been a highly successful case history of classical biological control.

MULTIPLE SPECIES INTRODUCTION OF COMPLEMENTARY NATURAL ENEMIES IN SUCCESSFUL BIOLOGICAL CONTROL. Masami Takagi, Naoki Sugiura (Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Assemblage of two introduced parasitoids, Aphytis yanonensis and Coccobius fulvus successfully control the arrowhead scale, Unaspis yanonensis in Japan. A. yanonensis is intrinsically superior to C. fulvus, as the former is an ectoparasitoid and the latter is an endoparasitoid. Moreover, reproductive potential of A. yanonensis is higher than that of C. fulvus because of shorter generation time and thelytoky. However, A. yanonensis does not displace C. fulvus in citrus growing area of Japan. They act as complementary natural enemies to the scale. A. yanonensis can control a severe outbreak of the scale more easily because of its shorter generation time. On the other hand, C. fulvus is a better agent to maintain the scale population at low level because its host resource is seasonally more stable than that of A. yanonensis. C. fulvus attacks both immature and mature female adults of the host. It is difficult for A. yanonensis to attack the mature adults, the more stable host resource. Moreover, fecundity and longevity of C. fulvus are higher and longer than those of A. yanonensis.

PARASITES OF ORTHOPTERA AND COLEOPTERA IN JOS, NIGERIA. E.N. Inyang, D.D. Duhlinska and E.B. Alo (Department of Biological Sciences, University of Calabar, Nigeria).

Studies were carried out on parasites of Orthoptera and Coleoptera pests of field and stored food crops in Jos. Important endoparasites observed in this study for both insect order were *Nosema, Amoeba* cyst, *Farinocystis, Adelina* and *Eugregarina* sporocysts. A mite sp., the only ectoparasite observed was found to be associated with Orthoptera (*Zonocerus* spp.). Female Orthoptera showed higher % infection (69.7%) than males (30.3%) with no significant difference between the infection rate of nymphs (55%) and adults (58%). The difference between infection rate of larvae (78.6%) and adults (20.5%) of *Tribolium* spp. (Coleoptera) was significant. Hypertrophy of cells, distruction of cytoplasm and nuclei and vacuolation of such cells was observed in histopathological examination of the insect organs and tissues. In terms of parasite load and number of parasite species in organ systems/tissues, the adipose tissue showed highest infection followed by the intestine and the malpighian tubules.

STUDY ON POPULATION DYNAMICS OF APHIDIUS AVENAE AND ITS ROLE IN CONTROLLING SITOBION AVENAE. Rui-wu Luo, Chongliang yang, yiu-fen Shang, Chang-song Li, Jiu-hua Zhao (Institute of Plant Protection, Shandong Academy of Agricultural Sciences, Jinan 250100, China)

Aphidius avenae H. is an important parasitic enemy to Sitobion avenae. It had not been observed that the aphidius could overwinter or oversummer in Jinan, and the results of laboratory test indicaded that the aphidius was susceptible to high or low temperature (no pupa survial below -10°C or 34°C for 3 days), which comfirmed to the results of field observation. The quantity of the parasites increased or decreased abruptly within a short period. Synchronous occurrence of appearing in mountain and plain, island and continent. The aphidius developing periods were sequential with each other in the north and south in eastern area of China. A hypothesis was put forward that Aphidius avenae migrated in long distance following Sitobion avenae from South to north with the aid of air currents in the east of China. Based on 17 years' data about population dynamics of Sitobion avenae and Aphidius avenae in Jinan, four typies of Aphidius avenae controlling Sitobion avenae was discussed as following: I. early occurrence of both aphid and aphidius, a great number of aphid which was controlled below economic threshold. II. early aphid occurrence, but late aphidius, a great number of aphid could be out of control, insecticides should be applied in the early stage of wheat and the aphid were controlled by aphidius late. III. late occurrence of aphid in a heavy population, which could not be controlled by aphidius, insecticides should be applied. IV. late occurrence of both aphis and aphidius, aphid population was controlled below economic threshold.

STUDIES ON THE BIOLOGY OF A TIPHIA WASP AND ITS UTILIZATION FOR CONTROLLING WHITE GRUB (HOLOTRICHIA OBLITA) IN PEANUT-CULTIVATED AREA. Yizhen Luo (Institute of Plant Protection, Shandong Academy of Agr. Sciences, Jiana 250100, China), Zhucheng Jiang (Plant Protection Station of Laiyang County, Shandong 265200, China)

Here is described the biology and usage of the Tiphia wasp (Tiphia sp.) parasitized on the white grub (Holotrichia oblita) in peanut cultivated area in North China. Tiphia sp. is highly specific to host species and its life history and parasiting time are phenologically synchronized with hosts. The emergence peak of the adult was just in the full emergence of the third instar host larvae. After emergencing, mating and feeding, females burrow into soil searching for grubs, inserting their stings into grub thoracic region and causing the grub in temporal paralysis, then, singly deposite eggs on ventral surface between meso and metathorax, each female lays 22 eggs in an average. Egg stage lasts for 4-8 days. The larva has four instars for 12-16 days, and consumes all tissues of the host, leaving the head capsule. The larva hibernates in the cocoon. Measures for utilization: (1) In peanut region, interplante supplementary food plants, such as Hibiscus cannobinus, Impoea batats, Phaseolus vulgris etc, to provide food sources. (2) Emigrate cocoons from parasite habitats to the highly infested region by grubs, with ratio at 1:10 (cocoons to grubs), (3) Intergrate measures with chemical control and agricultural practices to promote favourable ecological environments for colonization of parasites.

NATURAL ENEMIES OF GYPSY MOTH (LYMANTRIA DISPAR) IN KOREA. R.W. Pemberton, J.H. Lee (Asian Parasite Laboratory, USDA-ARS, c/o American Embassy, 82, Sejong-no, Chongro-ku, Seoul 110-050, Korea), D.K. Reed (USDA-ARS, Stillwater, OK, USA), R.W. Carlson (USDA-ARS, Beltsville, MD, USA) and H.Y. Han (Dept. Entomology, Pennsylvania State Univ., Univ. Park, PA, USA)

Thirteen season-long collections of gypsy moth larvae and pupae were made at seven forest sites near Seoul, South Korea from 1984 to 1989. Season-long parasitism rates ranged from 13.4 to 33.4% and averaged 23.8% overall. Thirty natural enemy species were identified, including 20 species that parasitized 12,388 of the 52,351 larvae and pupae reared during the study. Tachinid, braconid and ichneumonid species accounted for more 99% of this parasitism, with Tachinids being more important than Braconids, which were more important than Ichneumonids. The Branconid Cotesia melanoscelus, which parasitized 24.4% of 1st and 2nd instar larvae, was the most important parasitoid. Parasetigena silvestris (Tachinidae), which parasitized 27.6% of 5th and 6th instar larvae and 36.3% of the prepupae, was second in importance. Blepharipa schineri, a larval-pupal tachinid parasitoid, killed 37.5% of the pupae. The Nuclear Polyhedrosis Virus was the greatest mortality observed in the study, at times killing all of the collected larvae. About one third of the natural enemies, recorded in this study, have been reported in European gypsy moth studies, including 7 species that have been successfully established in the United States.

EFFECTS OF HOST DENSITY, EXPOSURE PERIOD AND ENVIRONMENTAL TEMPERATURE ON APHIDIUS GIFUENSIS AND DIAERETIELLA RAPAE. Hong Lu, Zhi-li Zhang, Bao-cai Shi(Institute of Plant and Environmental Protection, Beijing Academy of Agricultural and Forestry Sciences, Beijing 100081,China)

Host density, exposure period and environmental temperature which affected A. gifuensis and D. rapae laying eggs on Myzus persicae were studied. The number of eggs laid by these two wasps per day increased as the host densities raised, but the percentage of parasitism and super-parasitism decreased; the longer the aphids exposed under parasitoids, the more the number of eggs laid by the wasps, the higher the percentage of super-parasitism and the more aphids were parasitized by A. gifuensis, but under exposure for 6 hours the percentage of parasitism of D. rapae was higher than those under 2 hours and 24 hours. Higher temperatures(27-32°C) made A. gifuensis more active and lay more eggs than those under lower ones(23°C) during the first day after emergence. The results showed the suitable temperature for mass rearing A. gifuensis was 23°C and the ratio of parasitoid to host was 1:100.

THE IMPORTATION OF MICROCTONUS HYPERODAE LOAN (HYMENOPTERA: BRACONIDAE) A PARASITOID OF THE ARGENTINE STEM WEEVIL LISTRONOTUS BONARIENSIS (KUSCHEL) (COLEOPTERA: CURCULIONIDAE) INTO NEW ZEALAND AND THE OPPORTUNITIES FOR ECOLOGICAL EXPERIMENTATION. S. L. Goldson (MAF Technology, Ministry of Agriculture and Fisheries, PO Box 24, Lincoln, Canterbury, New Zealand).

The collection of Microctonus hyperodae from various locations in South America and its subsequent importation into New Zealand as a biological control agent of Listronotus bonariensis (Kuschel) is described. L. bonariensis is a major pest of the New Zealand's pastoral agricultural system and to a lesser extent cereal crops.

The relatively simplified habitat of the New Zealand pastoral environment and the absence of significant populations of other phylogenetically close weevil or parasitoid species, has presented the opportunity to develop experimental approaches designed to add to current biological control theory.

Initially, investigation was carried out to determine the extent and nature of any ecotypic differences in the imported parasitoid populations. This involved DNA and morphometically-based characterisation coupled with parallel analyses of differences in behavioural and developmental patterns. At the same time field investigations were commenced to determine factors such as the searching efficiency of the parasitoid, fecundity etc. More specifically an experiment was established which by dint of earlier systematic parasitoid release, should permit an investigation into the patterns of ecotypic establishment in the country's various climate zones. By analysis of the characteristics of the successful ecotypes, the aim is to eventually determine which factors conferred most advantage during establishment. In this way it is hoped to add to the general understanding of what underlying characteristics constitute a successful biological control agent. Progress to date is presented.

EFFICIENCY OF BIOLOGICAL CONTROL AGAINST CITRUS WHITEFLIES IN ITALY. S. Barbagallo, S. Longo, I. Patti, C. Rapisarda (Institute of Entomology University of Catania, 95123 Catania - Italy).

Three species of citrus-feeding whiteflies arrived in Italy during the last twenty-five years; they all have been efficiently controlled through biological methods and the serious problems deriving from their initial infestations were rapidly solved. In particular, *Dialeurodes citri* (Ash.), which invaded the Italian citrus orchards starting from the early sixties, has been pushed under low population levels by the introduction of *Encarsia lahorensis* (How.); thus the whitefly only occasionally injuries at present citrus groves, as a consequence of the relevant parasitization (up to 70-80%) by the Aphelinid. Two species of parasitoids have been more recently released for biological control of the woolly whitefly, *Aleurothrixus floccosus* (Mask.), which massively spread in Italy at beginning of eighties; one of them, *Cales noacki* How., well established itself in the new agrosystems, performing, in lack of limiting factors (i.e. high temperatures and low relative humidity), a generally appreciable control of the whitefly, in spite of the frequent late summer outbreaks of the latter. Recently, at last, appreciable activity has been locally shown by *Encarsia meritoria* Gah. against the latest whitefly arrived in Italy, *Parabemisia myricae* (Kuw.); yet the most successful results in controlling this insect have been obtained through the introduction from Israel of a species of the genus *Eretmocerus*, which allowed a quick reduction in the infestation levels by the whitefly.

LABORATORY AND EXPERIMENTAL EVIDENCE INDICATING THE DISCOVERY OF A NEW AND EFFICIENT PARASITOID-WASP OF HOUSE FLY-PUPAE (HYMENOPTERA, AGAONIDAE). S. Tirgari and A. Maadani (Department of Medical Entomology, Faculty of Hygiene, Tehran University of Medical Sciences, Iran)

From the stand point of biological control of different crop-pests and insects of medical and veterinary importance, usually many long lists of different organisms associated with them are available. That is the case with Muscoid flies and the house fly-pupae in particular. Legner (1976), Geethal Bai (1977) and World Health Organization (VBC/86.937) etc... have given out the list of parasites and predators associated with different growth-stages of house fly, including the pupae. So far, several species of pupal parasites belonging to the families of Pteromalidae and Spalangidae have been the subject of mass production and have commercially been used. However there are many other parasites that are so rare or lack the potentialities of being used for any purposes for the time being. In our study, one female of such scarce parasite belonging to family Agaonidae which had been found several years ago, was recently been used to parasitize the fly pupae. In all of our laboratory experimental tests for longevity, number of eggs, searching ability, rate of increase and morphologically, etc..., it shows to be superior to all common pupal parasites like *Muscidifurax* sp., *Spalangia* sp.. That are well known so far. This Agaonid-parasite is being the subject of mass production in laboratory.

SOME REGULARITIES OF FORMATION AND EVOLUTION OF COMMUNITIES OF CHALCIDOID PARASITES ON SOFT SCALE HOSTS. E.S.Sugonyaev (Zoological Institute, Russian Academy of Sciences, St.Petersburg 199034,USSR)

Communities of chalcid wasps infesting of soft scale insects have well regulated pattern formed by species of the same genera, and named taxonomical nucleus (TN). A stability of TN is dueto a strict delimitation of species functions, i.e. their ecological niches whichs are characterized 1)defenit host stage(s) infested by parasite, and 2)level of its food specialization. Modifications of TN take place when a "typical" genus is substituted by "untypical unallied one as a result of their biological convergance,i.e. by him ecological analogues. An evolution of soft scale parasites was a maltiple replication of their communities on a basis of the "protocommunity" with a defenit taxonomical pattern.

HYPERPARASITISM AND POPULATION DYNAMICS OF EPIDINOCARSIS LOPEZI,(HYMENOPTERA: ENCYRTIDAE) AN EXOTIC PARASITIOD INTRODUCED IN AFERICA FOR THE BIOLOGICAL CONTROL OF THE CASSAVA MEALYBUG. Juste Boussienguet (Programme National de Lutte Biologique, Laboratoire Tcheik Anta Diop(Zoologie fondamentale et appliqee) Univesite du Gabon B.P.1886 Libreville,Gabon)

Hyperarasitism is generally assumed to have a detrimentous impact upon population dynamics of parasitoids, reducing their abundance to the detriment of effective biological control effort. Field samples taken from Cassava during an outbreak of Phenacoccus manihoti(CM) in Gabon revealed that:(1)There is an inverse density dependent relationships between living CM density and the rates of hyperparasitism; (2) the primary parasitoid causes an inverse density dependent mortality to CM. Therefore, (3)the increase of hyperparasitism does not lead to an increase of CM density and (4) since hyperparasitism is concentrated within CM populations of lowest density, it contributes to avoid the overexploitation of the host by primary the parasitoid, and to facilitate the coexistence of the host-primary parasitoid interaction.

RELEASE OF APHIDOLETES APHIDIMYXA IN CONTROLLING COTTON APHIDS ON CUCUMBER PLNATED UNDER PLASTIC SHEET SHEDS. Yu-zhi Niu, Baocai Shi, Hong Lu, Zhi-li Zhang (Institute of Plant Protection, Beijing Academy of Agricultural and Forestry Sciences, Beijing 100081, China)

Aphid midges; aphidoloetes aphidimyza (Decidomyiidae) were collected in Beijing suburbs in autumn and fed with Megoura japonica reared on Vicia faba under laboratroy conditions for over 10 generations. In May, 4 releases of midges at weekly interval were carried out to control cotton aphid, A. gossypii, infested cucumber planted under plastic sheet sheds. The releaserates were 10, 20and 40 pupae per square metre, respectively. Application of fenvalerate-malathion and non-control were setup as the two checks. The midges population established successfully after releasing. The rate of reduction on aphid population was 63.94%, 94.32% and 87.62%, respectively, in the three treatmenls, as compared with the blank control one and a half months after releasing; and the increment in yields was 19.35%, 5.24% and 16.18% for the three treatments, respectively. Because of the appearence of most of the released midges were at the lower part of cucumber plants, they kept the aphid to a lower level at these portions, and thus suppressed the spreading of winged adults. Meanwhile, the spray check reduced aphid population to 90.32% and increased the yield to 21.91%, as compared with the bland check. However, considering that most of them had a pollution problem, the eatable cucumber from the yield was actually 34.01% less than the blank check.

THE PREDATION OF GREEN LACEWING ON COTTON BOLLWORM. Xiaofeng Dai, Yuyuan Guo (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

In 1987-1989, the natural population dynamics of green lacewing Chrysopa phyllochroma and its predation on cotton bollworm Heliothis armigera were studied in cotton field and laboratory in Xinxiang, Henan Province. There were 4-5 generations of this predator a year. Each generation followed closely to egg and 1st-instar stages of the corresponding cotton bollworm generation. The survey indicated that among the predators in cotton field, the green lacewing was the dominant species feeding on cotton bollworm.

In laboratory observation, the mean number of 1st instar larvae consumed by each green lacewing larva was 488. 1 and the predation amount day predator increased with the instar ages of predator. The predation efficiency varied with temperatures. The functional response to 1st-instar larvae of cotton bollworm, the function response to the density of itself, and the mutual interference among individuals were described as Holling's type II, Watt's equation and Hassell & Varley's model, respectively. The preference sequence of green lacewing to hosts tested in laboratory was given.

RESISTANCE OF OATS TO CEREAL APHIDS: EFFECTS ON PREDATION BY APHIDOLETES APHIDIMYZA (DIPTERA: CECIDOMYIIDAE). H.-L. Kuo-Sell (Institut für Pflanzenpathologie und Pflanzenschutz der Universität, Grisebachstr. 6, 3400 Göttingen, Germany), P. Sell (Institut für Angewandte Botanik der Universität, Marseillerstr. 7, 2000 Hamburg 36, Germany)

Larvae and adults of the predatory midge, *Aphidoletes aphidimyza*, were supplied with cereal aphids, *Metopolophium dirhodum*, reared on three oat cultivars, of which cv. Leanda was susceptible, cv. Selma moderately resistant and cv. Flämingsstern highly resistant to the aphids. The varietal resistance seemed not to influence the nutritive quality of the aphids for *A. aphidimyza* because larval development time, weight of larvae and adults, pupal duration and number of eggs produced from larval reserve substances were not affected. However, females laid fewer eggs if they took in honeydew produced by aphids feeding on Flämingsstern. Experiments carried out in closed systems showed that *A. aphidimyza* successfully controlled aphid populations on the two resistant cultivars within a shorter time than on the susceptible one. In both resistant cultivars the combined effect of host plant resistance and *A. aphidimyza* was proved to be additive. With increasing resistance, however, fewer offspring of the predator were produced, indicating a higher compatibility between the moderate resistance of Selma and the predator. For the use of plant resistance in integrated pest management programs cultivars of moderate resistance should therefore be recommended.

AGGREGATIVE RESPONSE AND PREDATION OF CYRTORHINUS LIVIDIPENNIS TO ITS PREY NILAPARVATA LUGENS. Qingcai Wei (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

The foraging time allocation by Cyrtorhinus lividipennis adult to rice plant containing different densities of their prey Nilaparvata lugens was investigated, as well as how the percentage of prey killed varies with initial density in different patches. The predator exhibited a clear aggregative response in high prey density patches, which possiblely resulted from C. lividipennis making more and longer visits to those patches. However, some predators leave the experimental area when predator density increase. Aggregation and dispersion reach to a balance point at predator density of 4. Despite of aggregation, direct density dependent predation can only be achieved before a critical density of 40 when the predator density is low and 20 when predator density is high. After that the relationship is inversely density dependent, which is caused by time limitation, satiation and strongness of aggregation in high prey density patches.

SOME OF THE LADY-BIRDS (COCCINELLIDAE)FAUNA OF SOUTHWEST,IRAN. M.S.MOSSADEGH AND F.KOCHEILI. Department of Entomology, College of Agriculture, Shahid Chamran University,Ahwaz,Iran.

From May 1987 to June 1989 during a faunistic survey, the larvae and adults of the lady-birds family (Coccinellidae) were collected from coltivated, noncoltivated plants, the orchards and other trees and bushes in different parts of the Khuzestan's province, southwest Iran. Some of the species that had been identified, belong to 16 species and 11 genra are as follow :

1. Adalia bipunctata L.; 2. Adonia variegata Goeze :
3. Chilochorus bipustulatus L. var. iranensis ;
4. Coccinella septempunctata L. ; 5. C. undicimpuntata L.
6. Propylaea (=Halyzia) quaturodecimpunctata L.
7. Epilachna chrysomelina Foure; 8.Hippodamia tredecimpunctata
9. Hyperaspis sp.; 10. Hyperaspis polita Weise
11. Scymnus (Nephus) quadrimaculatus Herbst
12. Nephus includens Kirsch;
13. Nephus sp. near fenestratus Sahlberg
14. Scymnus levaillanti Mulsant ;
15. Exochomus nigripennis (Erichson)
16. Stethorus gilvifrons (Mulsant)

Only 4 species of the lady-birds have been recorded earlier from Khuzestan province (Number 3, 4, 6 and 11). These were also collected in this survey. Among the species collected, number 7 is a pest of cucurbits family and the rest prey on various species of aphids, mites and coccids.

PRELIMINARY SURVEY OF NATURAL ENEMIES OF IMPORTANT AGRICULTURAL PESTS IN SOUTHERN PARTS OF YEMEN. Saeed A. Ba-Angood (Nasir's College of Agriculture, University of Aden Khormaksar O.O.Box 6172,Aden, YEMEN)

Several natural enemies have been recorded from major insect pests in southern parts of Yemen. The major predators observed on aphids and whiteflies were the coccinellids, syrphids and chrysopids whereas the major parasites were the Aphelinus and Aphidius species .Such natural enemies were found to contribute to cereal aphids control on wheat. The bollworm predators found on cotton were the chrysopids and some reduviidae bugs where as the parasites recorded species of caliphorid and tachinid flies. These were found to contribute to bollworm control in early sowing dates of cotton in the area. Several predators and parasites were reported which seem to have a potential contribution in reducing pest population of major agricultural pests of sesame, citrus and other vegetable crops. Some parasitic nematodes were found in the alimentary canal of some locusts and grasshoppers in the area. Bacteria fungi and insect viruses were also recorded from some agricultural pests in different areas of southern parts of Yemen. Some parasites and predators were also recorded from store pests in the area.

VARIATION OF PREDATION AND PARASITISM OF YELLOW STEMBORER, SCIRPOPHAGA INCERTULAS (WALKER) EGGS UNDER DIFFERENT RICE PLANTING DENSITY AND GROWTH STAGE. Li-zhi Luo (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094,China) B.M. Shepard (Coastal Research and Education Center, Clemson University, Charleston, South Carolina 29414, U.S.A)

Incidence of predation and parasitism of the yellow stemborer, Scirpophaga incertulas (Walker) egg(mass) and related natural enemies' population were monitored under four rice planting densities (900000, 660000, 550000 and 160000 hills/ha) and growth stages (20,40,60 and 80 days after transplanting (DAT)for two seasons. The egg predation among planting density was only significantly different at 20 and 40 DAT, but not at the later stages although the predators' population increased as the planting density increased and season progressed. Conversely, incidence of the egg parasitism was declined as the planting density increased and season progressed. Effects of planting density and crop age on the parasitism were obvious, but populations of the related parasites had no effect on it. At the higher planting density and later season not only the parasitism caused by single species declined, but also the number of species presented in the egg mass. Totally, mortality of the eggs caused by predators and parasites was significantly declined as the planting density increased and season progressed even though the related enemy population was inversely increased.

THE POSSIBILITY OF ECOLOGICAL PLANT PROTECTION IN HUNGARY. F.Kozár /Plant Protection Institute, Hungarian Academy of Sciences, H-1525 Budapest Pf.1o2 Hungary./

The ecological plant protection needs intensive studies in agroecosystems. It is clear that the agroecosystems are also relatively rich biocenoses with high number and often in high density of species of natural enemies of pests. In agriculture there is a widely distributed phenomenon of the natural biological control of insect pests. We can increase the efficiency of this natural control by special means what we call ecological plant protection. Such means are: diversification of agricultural landscape, conservation of natural refugies, preservation of natural enemies, attraction of natural enemies, intercropping, strip farming, use of biological control methodes, use of selective insecticides, border and local treatments, band treatments, use of warning and forecasting of pests and natural enemies. The application of these methods in plant protection, in the frame of integrated plant protection could help to reduce the use of insecticides against pest insects in agriculture. In Hungary the biological control methods have a restricted use and there are very few registered selective insecticides, now but we hope it would be increased in the future. The spreading of this idea and praxis of ecological plant protection would be important in most of the crops as wheat, maize, apple, pear, grapevine, etc. For what we need intensive education, too.

THE CONSERVATION AND AUGMENTATION OF NATURAL ENEMIES IN COTTON BY TRAP CROPS AND THE EFFECTS ON INSECT PESTS. Jian-zhou Zhao (Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, Beijing 100081, China), Qi-hua Yang & Ming-tsang Cheo (Department of Plant Protection, Beijing Agricultural University, Beijing 100094, China)

The effects of interplanting rape and sorghum between- or in- cotton rows as trap crops, with suitable ratios to maintain optimum density of cotton plants, on cotton insect pests and natural enemies were studied in Handan, Hebei province of China. The predators were found 5-15 days earlier and the number of predators increased by 24.9-50.7% in cotton with trap crops compared with cotton alone. It was obviously favorable for the restoration of the natural enemies by trap crops after applying insecticides in cotton. The densities and damages of the key insect pests, *Aphis gossypii* Glover and *Heliothis armigera* Hübner, became significantly less in cotton with trap crops, the chief mechanism of which was the attraction, conservation and augmentation of the natural enemies, especially for predators. This technique was proved to be effective and more economic and safe than the heavy use of costly insecticides. It is more valuable for the insecticide resistance management in cotton at present.

BIOLOGICAL CONTROL OF INSECT PESTS ON VEGETABAL CROPS IN BEIJING SUBURBS. Zhih Zhang, Ju-wen Wu (Institute of Plant and Environmental protection, Beijing Academy of Agricultural and Forestry Sciences, P. O. Box 2449, Beijing 100081, China)

The major vegetable crops, Brassica spp., cucumber, tomato, redpepper, eggplant and legumes, are mainly attacked by Pieris rapae, Mamestra brassicae, Plutella xylostella, Heliothis armigera, H. assulta, Myzus persicae, Brevicoryne brassicae, Lipaphis erysimi, Aphis gossypii, Trialeurodes vaporariorum, Polyphagotarsonemus latus, and Tetranychus cinnabarinus, etc. in Beijing Suburbs. In 1980's an investigation of natural enemies attaking insect pests on vegetable crops was carried out in large scale. 327 species, primary parasites and predators, belonged to 89 families were recorded. In early 1980', Encarsia formosa introduced from England to have controlled grasshouse whitefly successfully. At about the same time, Phytoseilus persimilis introduced to control T. cinnabarinus. In 1986-90, investigation and application of parasitoids (Aphidius gifuensis and Diaeretiella rapae) and predators (Aphidoletes aphidimyza) for control aphids were conducted. Other biocontrol agents, Trichogramma evanescens, Bacillus thuringiensis, Pieris rapae Granular Virus, Paecilomyces fumosoroseus var. Beijinese and Verticillium lecanii etc. against vegetable insect pests are mentioned. Also, integrated insect pest contral on vegetable crops is discussed.

THE BIO-INTEGRAL RESOURCE CENTER'S CHINA PROGRAM: INFORMATION EXCHANGE ON LEAST-TOXIC PEST MANAGEMENT TECHNOLOGY. William Olkowski and Sheila Daar (Bio-Integral Resource Center, PO Box 7414, Berkeley, California, U.S.A.)

The Bio-Integral Resource Center (BIRC) operates an International Technical Information Center on Integrated Pest Management. A major project is BIRC's China Program which facilitates communication between scientists, students, farmers, and policymakers in China and the United States concerned with least-toxic management of insect, weed, plant pathogen, vertebrate, and other pests.

BIRC regularly exchanges journals and other information with over 100 individuals and 30 institutions throughout China. BIRC's 10,000 volume library contains some 400 Chinese pest management texts and over 1200 articles from Chinese literature emphasizing biological control and other least-toxic pest control methods used by Chinese farmers and scientists. This information is stored and used on a computerized database management system. The collection focuses on practical field work that documents on-farm practices. Areas of emphasis include rearing and use of *Trichogramma* and other natural enemies; habitat management to provide alternate hosts and food for natural enemies; pheromones as attractants and mating disruptants; microbial controls; botanical pesticides; agroforestry; and farm designs that minimize damage from pests.

Other China program activities include publishing review articles and original research from China, hosting visiting scholars, translations, providing information on biorational Western pest management technology to China, and facilitating international distribution of Chinese pest control innovations.

THE PROSPECTS FOR BIOLOGICAL CONTROL OF STEM BORERS IN CEREAL CROPS IN SOUTH AFRICA. Rami Kfir (Plant Protection Research Institute, Private Bag X134, Pretoria, South Africa)

The most important pests of cereal crops in South Africa are the stem borers Busseola fusca (Fuller) (Lep. : Noctuidae) which is indigenous, and Chilo partellus (Swinhoe) (Lep. : Pyralidae) which came from India. Parasitism levels of up to 75% on borer's larvae by Cotesia sesamiae (Cameron) (Hym. : Braconidae) and 100% on pupae by Dentichasmias busseolae Heinrich (Hym. : Ichneumonidae) and Pediobius furvus (Gahan) (Hym. : Eulophidae) were recorded. These indigenous parasitoids reduced borer populations but their activity was not enough to reduce it to below economic threshold level. Two egg parasitoids, four larval parasitoids and two pupal parasitoids were recently introduced to South Africa for biological control of stem borers. The parasitoids Paratheresia claripalpis Van. der Wulp (Dip. : Tachinidae) from Brazil, Cotesia flavipes (Cameron) (Hym. : Braconidae) from Pakistan and Xanthopimpla stemmator Thunberg (Hym. : Ichneumonidae) from Mauritius were recovered in the vicinity of the release sites, but it is too early to determine if they have become established. Because of extreme climatic conditions in the main cereal producing areas, long diapause period by the borers and a very low rate of success of similar projects in other parts of the world, the prospects for satisfactory biological control of stem borers in South Africa by introduced natural enemies are poor.

BIOLOGICAL CONTROL OF PINK BOLLWORM. Ellington, J.J. (Entomology Plant Pathology and Weed Science Department, New Mexico State University, Las Cruces, New Mexico 88003). J. Jordon (Electrical Engineering Department, New Mexico State University, Las Cruces, New Mexico 88003).D. Davis, (Agronomy and Horticulture Department, New Mexico State University, Las Cruces, New Mexico 88003). T. Carrillo (Entomology Plant Pathology and Weed Science Department, New Mexico State University, Las Cruces, New Mexico 88003). We are in the second year of a three year IPM project in Egypt to biologically control pink bollworm in cotton. This project includes participation by scientists at Texas A&M University, University of California, Riverside and New Mexico State University. This project has six objectives:

1. Establish a synoptic arthropod collection from all of the major cotton growing regions in Egypt.
2. Collect, colonize and augmentatively release pink bollworm parasites from Australia.
3. Develop resistant host plants.
4. Develop a statistically relevant sampling, counting and evaluation system to access total arthropod population densities at the field site.
5. Develop an arthropod control decision rule (TEXCIM) for pink bollworm in cotton which includes the functional relationship between predators, parasitoids, primary consumers quality, earliness, yeild and price.

CHILEAN AGRICULTURAL PESTS WITH QUARANTINE IMPORTANCE IN EXPORT FRUITS AND VEGETABLES AND THEIR POTENTIAL FOR BIOLOGICAL CONTROL.

Francisco Cornejo Soms, Pest Management Specialist,Bio-Integral Resource Center,Spanish Program. Bo-Biotrol Company, Latin America Manager and Olalquiaga-Faure,Entomologist, Servicio Agricola y Ganadero, Chilean Federal Government. Literature examination, conversations with fruit and vegetable farmers, and personal experience have indicated that there are insects with quarantine importance which can interfere seriously in the production and export of fruits and vegetables from Chile. Of total fresh fruit exported from the southern hemisphere, Chile produces 31% of the apples; 23% of the pears; 80% of the grapes and 92% of the peaches and nectarines. Sales are close to a billion US dollars and will probably increase. There are political, economic, social, ecological, and entomological aspects to implementation of programs to reduce the use of broad spectrum pesticides in fresh exports of fruits and vegetables. Alternative pest control methods include least-toxic chemical controls such as horticultural oils, insecticide soap, sulfur, etc.; biological controls such as mass releases of predatory and parasitic insects and mites; microbial controls such as BT (*Bacillus thuringiensis*), granulosis virus of the codling moth, etc.; the use of botanical insecticides such as neem oil extracts, pyrethrum, etc.; and others. In addition, proposed programs include horticultural practices such as cover cropping, trap crops, intercropping, alley cropping, farmscaping and others. This paper also contains tables of tolerances of insect body parts and related contaminants useful for quarantine work. Discussions cover perceived potential for implementation of alternatives.

STUDYING OF THE LEAFHOPPERS OF GRAPEVINE AND THE CAUSE OF SUDDEN OUTBREAK OF THE PEST IN THE VINEYARDS OF OROMIE'H, W. AZARBAIJAN.

Mohammad Mostaan (P.O. Box 365, Oromie'h, Iran)

Studying of leafhoppers of grapevine in the years 1989-91, in the vineyards of Oromie'h (one of the outstanding areas of the country for viniculture) revealed that *Arboridia kermanshah* Dlab, as major and *Empoasca decipiens* Paoli, as minor species of leafhoppers were differentiated. From the natural enemies of the pest, a very active egg parasite of the genus *Angrus* and a predacious mite of the nymphal stage of the pest, out of the genus *Anystis* were identified. It was found that heavy treatment of vineyards against thrips, grapeberry moth and powdery mildew destroyed the natural enemies and are the main cause of pest outbreak in the region.

SPIDER AS BIOCONTROL AGENTS OF APHIDS IN WHEAT-THEIR FUNCTIONAL RESPONSE TO PREY DENSITY AND THEIR SUSCEPTIBILITY TO PESTICIDES. Fadel Mansour and Udo Heinbach (Newe yaar, P. O. Haifa 31999 ISRAEL.)

Laboratory experiments were perfomed to determine quantitatively the potential of dominant spider species in winter wheat in Germany, in suppressing the population of Ropalosiphum padi(L.) on wheat plants and their functional response to different aphid densities. The presence of spiders significantly caused between 34 and 58% reduction in aphid population development on wheat plants compared to the aphid population in the absence of spiders. The functional response curves for these spiders as predators of R. padi seem to describe a typical type II functional response. The killing curves-killing the prey without eating it-were of linera type. Laboratory experiments were carried out to evaluate the effects of three pesticides on dominant spider species: In general the Lycosids were more affected by pesticides than web-building spiders because their life stratgies. Sprayed sand as substrate fit the field conditions better as method to test the effects of pesticides on ground dwelling spiders.

THE ROLE OF PARASITES IN POPULATION DYNAMIC OF RICE LEPIDOPTEROUS PESTS IN NORTH VIETNAM. Vu Quang Con (Institute of Ecology and Biological Resources. National Centre for Scientific Research of Vietnam, Tuliem - Hanoi, Vietnam.

There is relation between evolution of oviposition types of host moths and parasitism levels by Tr. japonicum. Species Tel.dignus,Tel.rowani, Tet. schoenobii are playing very important role in restraint of T.incertulas eggs. Larval parasites being considerable important in dynamic of rice caterpillar populations are Cop.coni, A.cypris,A.schoenobii A.aff.ruficrus, C.hanoiensis, Cas.ajanta, R.parnarae. Main pupal parasites are X.flavolineata, Phaeogenes sp.,X.punctata.

The activity of separate species sometimes has limited character but activity of parasite complex (PC) is considerable. The parasitism by PC on C. medinalis larvae is up to 64% (average 34%),pupae 86% (26%),on P.guttata larvae 80% (33%),pupae 80% (50,3%), on T.incertulas eggs 95%,larvae 43% (28%), on N.aenescens eggs 87%, larvae 75% (56,3%).

There are 3 basic types of rice pest population regulation : 1- Regulation occurs on population level lower economical damaging threshold (EDT), 2- Sometimes pest population overtakes EDT, 3-non-regulation,hosts outbreak after some years.

FIRST ATTEMPT ON THE STUDY AND CONSERVATION OF TWO IRANIAN PARASITOIDS OF HOUSE FLY-PUPAE, *MUSCIDIFURAX RAPTOR* GIRAULT & SANDERS AND *MORMONIELLA VITRIPENNIS* WLK. (HYM. PTEROMALIDAE). S. Tirgari and M. Iranpour (Department of Entomology, Faculty of Hygiene, Tehran University of Medical Sciences, Tehran, Iran)

Biological control of house fly is being increasingly popular in the foci of fly production in industrial poultry production houses, etc..., particularly around the larger cities where their rapid expansion have embraced such fly producing foci in recent years in different countries. In the course of our nation wide survey of Arthropods associated with the wastes of domestic animals, the above species of parasitoid-wasps were found more abundantly. In laboratory studies on the biology of the above species, the life span of female and male *Muscidifurax* at 27°C, were 13.33 and 5.66 days respectively and that of *Mormoniella* 8.25 days. The female *Muscidifurax* laid 25 eggs, but *Mormoniella* enjoyed polyembryony in her reproduction. The full grown larvae of *Muscidifurax* (inside the puparium) were kept in temperature of 2°C. to 10°C with no significant mortality for 90 days.

Biological Control Agents: Insects, Mites, Spiders, etc. ——Their Utilization in Pest and Weed Management

INTRODUCED DUNG BEETLES IN WESTERN AUSTRALIA. Ian R. Dadour (Western Australian Department of Agriculture, Entomology Branch, South Perth, Western Australia, 6151.)

In December 1989 a 4 year programme was initiated to introduce 4 species of dung beetle (active from September to early January) from Spain to south-western Australia to control bush flies. This is a collaborative programme between CSIRO and the Western Australian Department of Agriculture (WADA). Previously the CSIRO in Western Australia demonstrated an 88% reduction in bush flies in January in the south west caused by the activity of introduced dung beetles which are summer active. There are 3 phases to the project, 1. Introduction of the 4 species of dung beetle to Australian Animal Health Laboratory in Victoria. Eggs which are produced by the adult beetles are extracted from brood masses, surface sterilized and shipped to Perth. 2. Mass rearing occurs in the quarantine facility at WADA and beetles are released into the south west. 3. Evaluate the impact of introduced dung beetles, both summer and spring active, on bush fly populations. The benefits of this programme will take time to accrue, but will have an impact on (a) the tourist industry as a result of less flies and (b) soil fertility as a result of increased dung burial.

HOST PLANT CHEMICALS AFFECTING GROWTH OF CHILO PARTELLUS (SWINHOE). Seema Das, Sangeeta Handa, S.C.Jain & H.C.Agarwal (Department of Zoology and Chemistry, University of Delhi, Delhi-110 007, India.)

Chilo partellus (Swinhoe) is one of the most important stem borers of maize and sorghum. Damage due to this pest may be reduced significantly by the use of resistant varieties. Four cultivars of maize (Zea mays L.) viz. CM600, Basilocal(BL), CM500 and Kisan, varying in their resistance to C. partellus in the field, were examined for their relative resistance to the stem borer in the laboratory in relation to nutrition. The rate of growth, food consumption and its utilization, egg laying and egg hatchability were studied. The insects showed better growth when fed CM 600 or BL maize as shown by higher pupation, higher larval and pupal weights and higher adult emergence as compared to CM500 and Kisan. The growth index decreased from 1.65 on CM600 to 0.09 on Kisan. The insects showed a better consumption and utilization of CM600 and BL. Number of eggs laid per female was 290 for CM600 reared C. partellus and 157 for Kisan reared insects and none of the eggs laid by the latter hatched. The degree of resistance of the cultivars to C. partellus on the basis of nutritional factors is : KISAN>CM500>BASILOCAL>CM600. Isolation and characterisation of the factor/s involved in this resistance could be of value in understanding and breeding for resistant varieties. Extraction, fractionation, identification and testing of the resistance factor/s from the above maize cultivars is in progress and the results will be discussed.

CONTROL OF DUNG BREEDING FLIES WITH DUNG BEETLES IN JAPAN. Nobuo Yamashita, Hirofumi Hayakawa (Tohoku National Agricultural Experiment Station, Shimo-kuriyagawa, Morioka, Iwate 020-01, Japan)

Dung breeding flies, such as Musca hervei, Haematobia irritans are serious pests of pastured cattle in Japan. Onthophagus gazella was introduced for the comparative studies of dung burying activity and suppressive effect on flies with domestic species from Texas, U.S.A. in 1983. We have established the mass rearing system of O. gazella, which produced several thousands beetles in one month with 100 rearing boxes (Rearing bed: sawdust covered with thin soil layer, 6cm depth, Density: 5 pairs / 5ℓ bed, Temperature: 30℃, Day length: 16L-8D, Humidity: 90%RH). Ecological studies predicted the northern limits of survival of O. gazella in Japan to be south part of Kyushu mainland, where the beetle developes 2-4 generations from early summer to mid fall, increasing its population geometrically. Since the summer of 1990, we have released the species at several points of Kyushu mainland and the southern islands (Yaku, Kuchi-no-erabu, Tokara and Kikai islands, confirming its overwintering on Kikai island). This was the first releasing of the foreign species in Japan.

FEEDING DETERRENTS AGAINST THE MIGRATORY GRASSHOPPER, *Locusta migratoria* (L.) IN BARLEY SEEDLINGS. Tohru Kanke and Yukio Ishikawa (Laboratory of Applied Entomology, Faculty of Agriculture, The University of Tokyo, Tokyo 113, Japan)

The migratory locust, *Locusta migratoria*, is oligophagous and usually feed on grasses. We found that nymphs and adults of this species do not feed on young seedlings of barley. In search for factor(s) responsible for rejection by the grasshopper, we firstly focused on gramine, 3-(Dimethylaminomethyl)indole, which is known as a main factor of the resistance against aphids in barley leaves (Kanehisa et al., 1990). We have examined the effect of gramine on feeding of the grasshopper in two bioassay methods using filter paper or fresh wheat seedlings as feeding substrates. Results of bioassay and quantification of gramine concentration in barley leaves by TLC and HPLC indicated that gramine can be a major factor for rejection, though the presence of other feeding deterrents cannot be denied. At present, we are in search for other feeding deterrent(s) in barley seedlings.

Biological Study of land Snails parasitoid Nyctia halterata (Diptera, Sarcophagidae) A.A. Nasrollahi (Iranian Research organization for science & Technology No. 71 Forsat Avenue, Tehran Iran) S. Tirgari (Faculty of Hygien, Medical Science University of Tehran).

The role of some land snails as intermediate host of human and animals parasitic diseases was less known until recently. Although they are considered as important pests of many agricultural crops. Frequent attempts has been made for biocontrol of land snails throughout the world with different degree of success. In Search of natural enemies of land snails Helicella Krynickii , We have found six sarcophagid flies.

The emergence of adult flies occures in early April and reaches its peack in October. Maximum rate of parasitism was measured up to 70% in sep. 1989 in the garden located in southern Tehran. The relative humidity was critical for the success of parasitism by fly, because the snails closed their helix aperture and they did not give any chance to the flies to deposit, Their larvae in our study we determined the larviparous of flies and one female may lay up to 3 young larvae at one helix aperture , Although the number of generations of N. halterata in not known, but its life cycle lasts about one month, several Hyperparasitic wasps from different families attacked fly pupae and reduced its population up to 35% in the field.

"USE OF VENOM-PRODUCTING ARACHNIDS FOR BIOLOGICALLY ACTIVE AGENTS IN KAZAKHSTAN". Ch.K.Tarabaev. (Institute of Zoology, Kazakhstan Republic Academy of Sciences, Akademgorodok, 480032 Alma-Ata, Kazakhstan Republic).

The spiders numbering about 40 thousand species, are the most represented group of venom-producting animals. For their venoms investigation and use in medicine and biochemistry, tens and hundreds of thousands of individuals of the most numerous and large species are annually capturing within Kazakhstan territory. There exists a problem of influence of mass capturing of these species on their populations and ecological situation. On the other hand, the venoms of not so numerous and large species remain inaccessible even for investigation.

The different ways of solution of these problems are given on the base of 6-years-old purposeful spiders investigations in Kazakhstan.

THE EFFECTS OF HERBIVORE DENSITY AND TIME OF ATTACK ON NODDING THISTLE. P.M. Keown, R.R. Scott (Department of Entomology, Lincoln University, New Zealand)

The effect of nodding thistle crown weevil, *Trichosirocalus horridus*, on noddding thistle, *Carduus nutans*, was investigated at different densities and at different times during the season. Four replicates of five different densities (0, 2, 9, 17,and 25 larvae per plant) were established in early and late treatments, one month apart in spring 1990. Various components of the thistle production were assessed on four or five occasions (depending on establishment time). With the early treatment, plant height, number of seed heads and total plant dry weight decreased with increasing larval density but the number of laterals and root:stem dry weight ratio showed no differences. In the early treatment, crown diameter was greatest with the highest larval density whereas the rosette diameter showed no differences between larval densities. With the late treatment, the rosette diameter decreased with increasing larval density. The relevance of these observations and the likely effectiveness of *T. horridus* in the biological control of nodding thistle will be discussed.

HOST SPECIFICITY TESTS OF EPIBLEMA STRENUANA [LEP.: TORTRICIDAE] A POTENTIAL BIOCONTROL AGENT OF AMBROSIA ARTEMISIIFOLIA AND A. TRIFIDA. Fang-hao Wan, Jian-qing Ding (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

Epiblema strenuana, a native North American stem-gall former of ragweeds, Ambrosia spp., was introduced from Australia to Beijing in 1990. The host range of the moth was tested and reinsured in outdoor cages with 38 species of economical crops, ornamental plants and closely related species with ragweeds representing 15 families. Results of all non-choice and choice tests showed that E. strenuana had a restricted hose range, only attacked and completed a life cycle on A. artemisiifolia, A. trifida, Parthnium hysterophorous and Xanthium sibiricum, and did not feeding any other plants and economic species of Compositae tested. These results are in good agreement with the preliminary test in Mexico, the detailed test in Queensland and as well as with the literature records. It is thus concluded that E. strenuana is safe to be used for controlling ragweeds in China.

NATURAL CONTROL EFFECT OF OVOMERMIS SINENSIS [NEMATODA:MERMITHIDAE] TO MYTHIMNA SEPARATA [LEP:NOCTUIDAE]. Guo Chen, et al.(Biological Control Laboratory, CAAS, Beijing 100081, China)

The mermithid nematode Ovomermis sinensis is an important endoparasite of the noctuid armyworm Mythimna separata. Its natural control effects are shown on three aspects. (1) The average parasitism from the data of 11-15 year survey in various kinds of wheat fields was 46%, with 73% as the highest. The mermithid parasite thus can effectively decrease the first generation population of host armyworm. (2) The feeding capacity of Armyworms attacked by O. sinensis decreased 38% in average. Most of them died before 5-6 instar. (3) The armyworm population in its first-brood breeding site is suppressed since the existence of Ovomermis. The entering amount of the armyworm to second-brood area is reduced.

The main factors, which influence the parasitism rate for an average year, are the overwintering density of mermithid adults in early spring, days for raining, rainfall and relative humidity from last ten days of April to the second ten days of May. It had successful practices is using O. sinensis as an biocontrol agent of armyworms in wheat fields.

STUDIES OF ENTOMOGENOUS NEMATODE STEINERNEMA FELTIAE FILIPJEV FOR CONTROL OF STRIPED FLEA BEETLE, PHYLLOTRETA STRIOLATA (FABR.)
Wei Hongyi (Jiangxi Agriculture University, Nanchang 330045)
Wang Guohan (South China Agriculture University, Guangzhou 510642)

Field trials in this paper were conducted in Guangzhou and Shenzhen in 1989-1990 to determine the efficiency of the nematode Steinernema feltiae Filipjev (J3) for control of striped flea beetle (SFB) Phyllotreta striolata (Fabr.). Soil application of 1,000,000 nematodes/m^2, resulted in 40--70% infection of SFB' larvae and 38--84% control efficiency, and similar result was achieved with application 500,000 nematodes/m^2 mixed with trichlorphon (1:1000). Within 15 to 20 days, Steinernema feltiae could suppress population density of SFB.

EFFECTS OF INOCULUM SIZE, TEMPERATURE AND TIME ON *IN VITRO* PRODUCTION OF *STEINERNEMA CARPOCAPSAE* AGRIOTOS. Richou Han, Li Cao, Xiuling Liu (Guangdong Entomological Institute, Guangzhou 510260, China)

Effects or interactions of bacterial and nematode inoculum sizes, temperature and culture time on the growth and yield of *Steinernema carpocapsae* Agriotos were established in sponge culture system with an artificial medium containing yeast extract, soy flour, egg, and lard in 500 ml flasks. Nematode inocula were added into 50 g of the autoclaved medium. 3 days after incubating the medium with primary form (phase) of the symbiotic *Xenorhabdus nematophilus* bacteria at the coded temperature levels of 15, 19, 23, 27, 31°C. Yields of infective juveniles were significantly affected by nematode inoculum size ranging from $3x10^2$ to $3x10^6$ per flask and by culture time ranging from 8 to 24 days but not by bacterial inoculum size in the same coded range as nematode inoculum. The normal temperature range for *S. carpocapsae* was 19-27°C with 19-23°C supporting optimal growth. Pronounced negative interactions between temperature and culture time, between temperature and nematode inoculum size, and between nematode inoculum size and culture time were observed. The highest yield of $38x10^6$ per flask was obtained with $3x10^5$ inoculum in 20 days at 19°C. The results suggested that for economic production of nematodes within the optimal level of temperature, nematode inoculum and culture time must be kept in balance for maximum utilization of the medium and for maximum formation of infective juveniles

TAXONOMIC STUDY OF THE GENUS: *STEINERNEMA* TRAVASSOS & *HETERORHABDITIS* POINAR. Jie Liu(Guangdong Entomological Institute, Guangzhou 510260, China)

41 strains/species of namatodes in the genus: *Steinernema* Travassos & *Heterorhabditis* Poinar were collected or isolated from China and other countries. The cross-breeding, morphological observation, isozymes electrophoresis combining with cluster analysis methods were used in the taxonomic study of the genus: *Steinernema* Travassos & *Heterorhabditis* Poinar. Two new species from China were described: 1. *Steinernema serratum* sp. nov., the diagnosis was the female of first generation having a serratulate terminal projection on the tip, length of infective stage larvae was 928 μm. 2. *Heterorhabditis brevicaudis* sp. nov., the diagnosis was the short tail (only 75.5μm in length) in infective stage larvae, the excretory pore located posterior to the nerve ring, but anterior to the base of pharynx in adults. The results of cluster analysis for the nematodes isozyme characters were reflected present classification of the nematodes in certain degree. It was suggested that 22 strains of *Steinernema* nematodes examined represent 9-10 species, including 2-3 undescribed species and 19 strains of *Heterorhabditis* nematodes examined represent 4-5 species, including 1-2 undescribed species.

POPULATION DYNAMICS OF *STEINERNEMA CARPOCAPSAE* IN *IN VITRO* LIQUID MONOXENIC CULTURE. Jin-xian Wang (Guangdong Entomological Institute, Guangzhou, China but presently CSIRO, Division of Entomology, Australia) and Robin A. Bedding (CSIRO, Division of Entomology, Australia)

Population development of *Steinernema carpocapsae* in liquid culture is significantly influenced by the sizes of initial inocula. With an inoculum of 15 million nematodes per flask (50g medium shaken in 500 ml flasks at 23°C, n= 5), the final yield of nematodes was only a sixth of the initial inoculum, while there was a greater than 9,000 fold population increase from an inoculum of 800 nematodes per flask. The final yields of infective juveniles from inocula of 800, 8,000, 80,000, 800,000 and 16 million per flask were 7.2, 8.5, 10.2, 15.5 and 2.6 million respectively (ie from 52,000/ml to 300,000/ml). Mechanisms identified as important in population control included differential arrestment in the infective juvenile stage, variation in the contribution each generation made to the final population and, a variation in the number of generations. The length of time needed for the nematode population to develop to almost entirely infective juveniles varied from 6 weeks for 800 nematodes per flask to 3 weeks for 800,000 inoculum with an unexpectedly long period of 5 weeks for the inoculum of 15 million. The significance of the population density of the symbiotic bacterium, *Xenorhabdus nematophilus*, in the growth, reproduction and population development of the nematode were also studied.

DESCRIPTION OF A ENTOMOPATHOGENIC NEMATOD: STEINERNEMA LONGICAUDUM sp. nov. AND ITS APPLICATION. Chang-peng Shen (Laiyang Agricultural College, Laiyang city, Shandong 265200, China), Guo-han Wang (South China Agricultural University, Guangzhou 510642, China)

Steinernema longicaudum sp. nov. was collected in Laiyang, China. Studies on morphological, hybidization, esterses disc electrophoresis and symbiotic bacteria showed differences between this species and other members in the genus. It was distinguished from other species of the genus by having the greatest atail average length (>900um) of infective juvenile. Its characters included infective juvenile length, shape of spicules and absence of a tail projection in male. It was similar to S. glaseri, but different from the latter in: 1. absence of a tail projection in frist generation female; 2. spicules wider and curved strongly, without a ventral hook or scar in tip; 3. both of ratio C and E smaller. It differed from S. anomali in: the peculiar structure of spicula tip, presence of a bulblike expansion with a pore, the excretory pore located at the level of the basal oesophageal bulb (in males) in S. anomali, but the new species has not those characters, and 18 measurements that were not overlapping on both ranges. Its development, host range, controlling tests of Clanis bilineata larvae, and morphological, physiological and biochemical measurements tests of symbiotic bacteria were confirmed. The symbiotic bacteria was identified as Xenorhabdus nematophilus. The corrective mortality of Clanis bilineata larvae were 90% in outside tests and 50-93% in indoor tests at 22-26 C. The optimum temperature was 24 C and the clay soil was unfavourable to its infecting.

DISINFESTATION OF ARTICHOKE STUMPS WITH ENTOMOPATHOGENIC NEMATODE AGAINST THE ARTICHOKE PLUME MOTH. Mohammad A. Bari, (Artichoke Research Association, Salinas, CA 93905)

The feasibility of using entomopathogenic nematode, Steinernema carpocapsae (All strain) for disinfection of artichoke stumps against the artichoke plume moth larvae was assessed for a large-scale artichoke planting. A metal tank to hold nematode suspension and a hanger to lift and immerse wooden bins with a fork-lift in the nematode suspension tank were devised. Each wooden bin (4x4x2.5 ft) could store up to 10 bins were needed to plant one acre.

Three levels of nematode concentrations in the suspension tank were tested for the control of plume moth larvae. Significantly lower shoot infestation and larval density as compared to untreated control were recorded in the field with the three concentrations at 3, 5, and 8-week postplanting. Differences in control obtained by the three concentration, however, were not significant.

Immersing artichoke stumps in a nematode suspension with 320 infective juveniles per ml was found to be an economically feasible method for disinfesting artichoke stumps against plume moth on a commercial scale.

COMPARATIVE STUDY ON THE QUALITY OF *STEINERNEMA CARPOCAPSAE* CULTURED BETWEEN IN *VITRO* AND IN *VIVO*. H. W. YANG, H. JIAN, S. G. ZHANG, and G. Y. ZHANG. (Biological Control Laboratory, CAAS, Beijing 100081, China)

Steinernema carpocapsae Beijing was cultured with 3 different media in *vitro* and with Galleria larvae in *vivo*. The major ingredients in each artificial medium were vegetable protein (A medium) and animal protein (B medium) and vegetable plus animal protein (C medium), respectively. In *vitro*, the volume of $0.5x10^6$ stock nematodes was inoculated into a 500ml flask with 50g in each medium for 20 days, and in *vivo*, 300 nematodes were introduced into a plastic jar filled with moisture sand burled with 5 Galleria larvae. The harvested nematodes were tested in length, weight, and the intensity established into Galleria larvae within 24 hrs exposure and vertical dispersion in sand. The results indicated the best nematode from *vivo* culture, next from B and C media, the poorest nematodes from A medium. The average length of infectives was 0.56, 0.509, 0.495, 0.467 mm, the average weight of per million infectives was 85.06, 56.41, 61.13, 51.79 mg, the average number invaded per cadaver was 9.4, 8.7, 7.5, 2.0, respectively. The nematode cultured in *vivo* could disperse to 15 cm depth in sand within 48 hrs, the nematode from B and C media to 10 cm, while the nematode produced by A medium only stayed in 0-5 cm.

CONTROL OF THE SUGARBEET WEEVIL (Conorhynchus mendicus Gyll.) WITH ENTOMOPATHOGENEIC NEMATODES IN ITALY. Boselli M., Curto G.M., Tacconi R., Pollini A. (Osservatorio Malattie delle Piante - Bologna 40129, Italy), Deseo K.V. (Institute of Entomology "G. Grandi", University of Bologna, 40126 Italy)

The Sugarbeet Weevil (Conorhynchus mendicus, Gyll.) (Coleoptera; Curculionidae) can sometimes cause 90% damage in the Italian sugarbeet cultivation. Adults can be controlled by chemicals. Against larvae successful field trials were carried out in the last years with entomopathogenic nematodes (e.n.).-In 1991 two commercial preparations were compared: Heterorhabditis sp. of BIOERRE (I) and S. carpocapsae of BIOSYS (USA). - E.n. were applied in two concentrations: 250,000 and 500,000 juveniles/sqm. In the controls insecticides or pure water were used. The surface of each replicate was 80sqm. Results showed that: the parasitism rate was higher with Heterorhabditis than with Steinernema and higher in clay than in clay-peat soil (84-45% and 38-29% respectively); the damage of the weevil was the smallest with two treatments; the efficacy of e.n. was about 83%, while with the chemical it was only 4.6%; notwithstanding the difference in the parasitism rate, the saccarose content of the harvested beet was the same with both e.n. preparations and it was 100% higher than the chemical and 130% higher than the control irrigated with pure water.

COMPONENTS OF ECOLOGICAL COMPETENCE AND THE DIFFERING NICHES OF NEMATODES OF THE HETERORHABDITIDAE AND STEINERNEMATIDAE

Martin J. Downes (Department of Biology, St. Patrick's College, Maynooth, Co. Kildare, Ireland.)

Nematodes of these two groups occur together in some soils. They differ with respect to features of their life-cycles, means of gaining access to insect haemocoels, persistences in soil and characteristic abundances. This paper explores how factors such as these may be differently integrated in their contributions to the success of the two nematode types in the wild.

USE OF ENTOMOGENOUS NEMATODE, STEINERNEMA KUSHIDAI FOR CONTROLLING ANOMALA CUPREA. A.Fujiie, T.yokoyama(Chiba Prefectural Agricultural Experiment Station, Chiba 280-02 Japan) and M.Fujikata (Chiba University, Matsudo 271, Japan)

The pathogenicity of the infective juveniles (JIII) of S.kushidai to A.cuprea, which is one of major pest of crops such as peanuts, sweet potatoes, etc. and of turfgrass, was investigated. Experiments on the control of A.cuprea were also carried out in pots and in a peanut field. S. kushidai remarkably propagated in the bodies of the 3rd instar larvae of A.cuprea, and 29890 JIII per larva were detected on an average. The pathogenicity of JIII to the 3rd instar larvae was higher than that to the 1st and 2nd instars. When the progenies of S.kushidai were sequentially inoculated to the 3rd instar larvae, the pathogenicity of JIII and propagation of JIII in the bodies of many larvae were higher during a 20.5 month period. Thereafter no propagation of JIII was observed, although the pathogenicity remained high. When the JIII were introduced in pots planted to turfgrass, the feeding damage was negligible and the net photosynthesis rate was normal. In the peanut field, JIII were effective for the control of A.cuprea, while the peanut field without JIII sustained severe damage.

#1

COMPARATIVE STUDIES OF GEOGRAPHIC/HOST POPULATIONS OF TRICHOGRAMMA DENDROLIMI MATSUMURA IN CHINA, I. REPRODUCTIVE COMPATABILITY. Xu Wei-liang, Liu Shu-sheng, Shi Zu-hua, Wu Xiao-jing, Xu Zhi-hong, He Jun-hua (Biological control laboratory, Zhejiang Agricultural University, Hangzhou 310029, China)

Interbreeding experiments with 72 different combinations were conducted among ten populations of Trichogramma dendrolimi Matsumura collected from five Dendrolimus species distributed from 22°N to 43°N in China. Fecundity, sex ratio and pupal mortality of offspring in both cross and backcross experiments were analysed statistically with those of intra-population treatments. The results revealled no evidence of reproductive isolation among the ten populations. Considering the ten test populations are reasonablly representive of the species in China, it is concluded that the geographic/host populations of T. dendrolimi Matsumura parasitizing Dendrolimus spp. across China still remain reproductively compatable and no reproductive isolation has occurred.

#2

COMPARATIVE STUDIES OF GEOGRAPHIC/HOST POPULATIONS OF TRICHOGRAMMA DENDROLIMI MATSUMURA IN CHINA, II. THE ABILITY OF AVOIDING SUPERPARASITIZATION. Shi Zu-hua, Liu Shu-sheng, He Jun-hua (Biological Control Laboratory, Zhejiang Agricultural University, Hangzhou 310029, China)

Comparative studies of the ability of avoiding superparasitization were carried out in six populations of Trichogramma dendrolimi Matsumura collected from five Dendrolimus species, 22°N to 43°N in China. Eggs of the rice moth, Corcyra cephalonica Guen., were used as host in the observations, and the acceptance/contact ratio was taken as the index to measure host discrimination. The observation records were analyzed statistically. The results showed that females in each of the six populations are able to strictly discriminate between unparasitized host eggs and host eggs parasitizd either by itself or by other individuls of the same or another population, and no significant differences were detected in their ability of avoiding superparasitization among the populations tested.

#4

THRESHOLD TEMPERATURES AND THERMAL CONSTANTS OF 5 DIFFERENT COLONIES OF Trichogramma evanescens DEVELOPING ON EGGS OF Corcyra cephalonica AND Mamestra brassicae. Bao-de Wang & Zhi-li Zhang, (Institute of Plant and Environmental Protection, Beijing Academy of Agricultural and Forestry Sciences, P.O. Box: 2449-19, Beijing, 100081 China)

Wasps of Trichogramma evanescens collected from different areas and (or) on different host eggs were reared on C. cephalonica for at least 10 generations, then some of the wasps were changed to be reared on M. brassicae, others were still reared on C. cephalonica under 6 different temperatures in order to get the Threshold Temperature(C) and Thermal Constant(K) of the 5 colonies developing on the 2 hosts.

The results of the experiment showed that K and C might differ among the 5 colonies when they were reared on the same host eggs. For example, C of colony 1, collected on eggs of Peris rapae in Shanxi province, China, was 9.02 C, which was significantly lower than colony 2, collected on eggs of M. brassicae in Beijing; K of colony 1 and colony 2 was 145.04 and 129.68 respectively. Even wasps of the same colony might have different K and C when developing on different host eggs. Take colony 1 as an example, when reared on C. cephalonica, C and K of this colony were 9.02 C and 145.04, respectively; While, C and K were 11.37 C and 118.06, respectively, when it were reared on M. brassicae. K and C of the other 4 colonies showed no significant difference when they developed on the 2 host species.

#5

BEHAVIORAL VARIATIONS AMONG DIFFERENT COLONIES OF TRICHOGRAMMA OSTRINIAE FROM CHINA. Baode Wang, Juwen Wu, Suqin Wang (Institute of Plant & Environmental Protection, Beijing Academy of Agri. & Forestry Sciences,Beijing 100081, China) D. N. Ferro (Department of Entomology, University of Massachusetts, Fernald Hall, Amherst, MA 01003, USA)

Wasps of T. ostriniae were reared from eggs of the Asian corn borer, Ostrinia furnacalis (OF), collected from field corn. Ovipositional behavior of T. ostriniae was studied at different temperatures and for different parasite hosts. After several generations of being reared continuously on eggs of O. furnacalis, a population of T. ostriniae was generated by exposing wasps to eggs of the factitious host, Corcyra cephalonica (C C). The number of wasps emerging per parasitized egg decreased as the number of generations increased (F_1= 1.6 wasps, F_7 = 0.3 when reared on OF .and for CC was F_1 = 0.4, F_7 = 0.06). Percentage of female wasps also declined with an increase in generations. Number of eggs parasitized per day was highest for OF F_1(16.6) and lowest for CC F_7 (2.5). Maximum parasitism, number of wasps per egg and percentage females occurred at 24℃ for all generations, however the levels of parasitism were very similar from 20 to 28℃. O. furnacalis is a better host for rearing T. ostriniae than C. cephalonica. It took approximately 7 days for T. ostriniae to go from egg to adult at 28-33℃ and 20 days at 17℃.

#6

FERTILITY AND LIFE TABLE STUDY FOR TRICHOGRAMMA SP. NR. MWANZAI Qing-guang Lu (Biological Contrlo Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

This study conducted in the ICIPE is the first report on fertility and life table of a native wasp, Trichogramma sp. nr. mwanzai Schulten &Feijien, a predominant egg parasitoid of Chilo partellus in Kenya and Africa. Under five constant temperatures of 35, 30, 25, 20 and 15℃ the intrinsic rate of natural increase r_m of the wasp has the value of 0. 4603, 0.4075. 0.3337, 0.1101 and 0. Net reproductive rate R. and finite rate of increase were also determined. The native wasp has relatively high biotic potencial by comparison with the r_m value of some species of Trichogramma used widely suggesting that T. sp. nr. mwanzai might be the most promising agent for biological control of C. partellus in this region.

#7

STUDY ON MALE ADULT'S COPULATING WITH FEMALE PUPA AND SEXUAL RATE IN THEIR PROGENIES IN REPRODUCTION OF TRICHOGRAMMA DENDROLIMI. Jian Kong (Institute of Plant Protection, Henan Academy of Agricultural Science, Zhengzhou 450002, China)

Observation with microscope and the recorded film by cinecamara showed that male adult's copulating with female pupa occured when Trichogramma dendrolimi parasitized in oak silkworm eggs. 59% of female pupa requiring 5 hours to emerge were fertilized and could produce both male and female progenies among which the female sexual percentage reached 82% that was near the normal level in Trichogramma mass production with rice moth eggs and oak silkworm eggs. The female pupae requiring more than 24 hours for their emergence only produced male progenies after they developed to adults, which showed that these female pupae were not fertilized though the mating between them and male adults was seen. The potential effect of this unusual mating behavior to Trichogramma mass production was discussed in the paper.

#8

AFFECT OF RELEASING NUMBER AND HOST DENSITY ON PARASITISING EFFICIENCY OF TRICHOGRAMMA. Ming-fang Guo, Li-ying Li (Guangdong Entomological Institute, 105 Xingang Road West, GuangZhou 510260 China)

By means of mass rearing and releasing of Trichogramma to control lepidopterous pest on forest, corn, rice, and surgarcane is quite popular in China. It has been found in practice of biological control, however, that the releasing efficiency of Trichogramma was not satisfactory sometimes as imagined. For this problem, the study of the affect of releasing number of wasps and host density (Corcyra cephalonia (Stainton), Cnaphalocrocis medinalis Guenee) on parasitising efficiency of Trichogramma japonicum Ashmead has been conducted in laboratory, cages in the field and rice paddy field in nature respectively. In spite of the experiments under different environment, the results all showed that (1) when the released number of wasp was constant and host density was changeable, the number of parasitized host increased with the increase of host density, but the percentage of parasitism decreased, (2) when host density was constant and the released number of wasp was changeable, the number of parasitized host and the percentage of parasitism both increased with the increase of wasp density and it showed an increasing logarithmic curve.

#9

LYOPHILIZED DIETS FOR IN VITRO REARING TRICHOGRAMMA DENDROLIMI & BRACON GREENI. Wenhui Liu, ShuoYang Wen, Qiaoxian Chen, Li Li & Liying Li (Guangdong Entomological Institute, Xingang West Road 105, Guangzhou, 510260, China)

Successful artificial diets, containing pupal haemolymph of Antheraea pernyi, chicken yolk, milk etc. for in vitro rearing Trichogramma spp. and Bracon greeni were achieved in China during 1975 - 1989. The effectiveness of in vitro method depends upon several factors, among them the quality of diets (especially of the insect haemolymph) is very important. Commonly cold-stored haemolymph or prepared liquor-diets is not always suitable to parasitoids. In this paper, lyophilized diets, stored under -16°C (for T. dendrolimi) or 4°C (for B. greeni) and in room temperatures (25-30°C) for several months to 1.5 year were compared with the non-lyophilized liquor-diets (fresh ones or cold-stored in -16°C). There was no significant difference in parasitism and development of the parasitoids, reared in lyophiliaed diets, either cold stored or stored in room temperatures, in comparison with those in fresh diets. Sometimes cold-stored lyophilized diets were better than the others. 18 kinds of amino acid were also analized. No significant change was found. It proved that lyophilized artificial diets are available and convenient for in vitro mass rearing, storage and shipment of these 2 kinds of parasitoids in large number.

#10

TECHNIQUES FOR ARTIFICIAL MULTIPLCATION OF TRICHOGRAMMA DENDROLIMI MATSUMURA IN A LARGE QUANTITY. Shu-yi Zhang, Fu-cheng Wang (Cotton Research Institute, Shanxi Agri. Sci. Academy, Yuncheng 044000, China)

1. Four steps to keep Trichogramma Dendrolimi Matsumura(TDM) parasited in the eggs of Antheraea Pernyi Guerin-Meneville(APGM) alive for more than 6 months: (1) Use only one-day-old lavars. (2) Place the selected lavars under 7°C, 5°C, 3°C, and 0°C for 4 days, 3 days, 2 days, and 2 hrs, respectively for short time physical training. (3) Store the treated lavars in 3°C cold room. (4) graduaty increasing the temperature for recovery. 70% eclosion rate can be expected.

2. Under low temperature(3°C±0.5°C)and vacuum(360-460 psi) condition in stores, the eggs of the APGM can be kept fresh for 6 months. And about 80% of such eggs can be parasited by TDM. The eclosion rate can be 90%.

3. Use an improved easy-made machine for multiplication.

In 1988, 1250 million TDM were reproduced in this way, and released in about 1500 ha. vegetable fields in Linfen Prefecture in Shanxi Province. The parasitic rate was about 70%. 75000T non-polluted vegetables was harvested. 0.37 million yuan for pesticides was saved, and the natural enemies in the fields increased from 8 species to 60 species more. Ecological, economic and social effects were significant.

#11

THE STUDY ON THE SERIAL APPARATUS FOR THE PROVISION OF RICE MOTHS FOR THE REARING OF TRICHOGRAMMA Yun-ning Zhou, Xiao-xiu Zhang, Jun-sheng Zhao. Tang Li (Shanxi Plant Protection Institute, Taiyuan 030031, China)

The pest control by Trichogramma in agriculture and forestry is one of effective measures in China and abroad. To resolve the deficiency of rice moth eggs as intermediate parasite host, we have undertaken the medium-sized research of the improvement on the serial apparatus for the provision of rice moths for the rearing of Trichogramma on the basis of small-sized one. which had completed during 1980-1986. The principle of the design is to reduce labour intensity, avoid environmental contamination and protect operators health. Sametime, we insist on sharp, efficiency of the apparatus. Now, we developed serial apparatus of medium-sized experiment and relevant techniques. The medium-sized workshop is in application and result is good.

We have developed the feed-mixer, moth-catcher, ovipositor-lodgement, refuse-collector, egg-killer, egg-deployer and wasp-receiver according to the process of the moth rearing.

#12

THE INFLUENCE OF RELEASING TRICHOGRAMMA SPP. TO THE POPULATION OF CORN BORER. Xiao-cheng Shen (Institute of Plant Protection, Henan Academy of Agricultural Sciences, Zhengzhou 450002, China), Ke-zeng Wang, Zhen-sheng Fu, Mei-hua Qin (Plant Protection Station, Lankao County, Henan Province 475300, China)

Based on the population of corn borer, Ostrinia furnacalis, in 1964-1990, an analysis on the influence of releasing Trichogramma spp. against the pest was carried out in Lankao County, Henan Province, China. Egg masses of 1-3 generation and overwintering larvae per 100 plant were 49.9, 33.8, 276 and 230.9 respectively in 1964-1973 by chemical control. In 1974-1981, T. dendrolimi and T. chilonis were released continually The totalarea of releasing the wasp were 120000 hectare for controlling the borer. The population of corn borer has been reducde to 33.3, 12, 56, and 41, respectively. Since 1982 changing bio-control to chemical, population of the pest arose slowly. Mean population in 1982-1990 were 117.2, 7.07, 26.2 and 58, respectively. Hotelling T^2 multiple variable comparison were made between the 3 periods by MINITAB programme. The test showed that there were significant difference between the 1st and 2nd periods, and 1st and 3rd periods, but there was no real difference between the 2nd and 3rd periods.

#13

REPRODUCTION AND APPLICATION OF TRICHOGRAMMA SPP. WITH EGG OF RICE MOTH. Yu-zhuo Zhang, Mei-zhen Cheng and Yu-jun Li (Peixian County Plant Protection Station, Jiangsu Province, China).

The method for breeding Trichogramma spp. using eggs of rice moth (Corcyra cephalonia) has been researched for many years, some good techniques have been developed as follows:

1. Rearing and reproduction of rice moth with big-bed. Rice bran mixed with water was used as diet. The larvae were reared on square dish. The moths oviposited in flat cage. In this way 8.4-12.6 thousand eggs could be produced on 1 kg diet, reproduction multiple was about 30.

2. Eggs of rice moth were adhered on plate glass for reproduction of T. spp. using mechanical technique, 484 million individuals of T. ssp. were reproduced each day.

3. The eggs of rice moth were storaged for 24 hours under the conditions of 25°C and RH 75%, then they were put into the refrigerator at 10 2°C. When the temperature dropped to 4 1°C, the colour of eggs changed. The eggs could be storaged safely more than 100 days.

4. Releasing T. spp., for the control of the second generation of Heliothis armigera Hubner. The parasitic rate of Trichogramma spp. on eggs of Heliothis armigera was 40-79.9%.

#14

UTILIZATION OF ARTIFICIAL HOST EGG-WASPS FOR CONTROL OF INSECT PEST IN ARGICULTURE AND FORESTRY. Kai-jia Dai, Zhi-jian Ma, Liang-wu Zhang, Ai-hua Cao (Department of Biology, Wuhan University, Wuhan 430072, China)

The mechanization of producing artificial host egg cards and propagating wasps by them have been realized in China. The productivity of the assembling line is about 30,000,000 wasps for *Trichogramma dendrolimi* or 20,000,000 wasps for *T. chilonis* per day. Until 1990, the artificial egg-*T. dendrolimi* have been used to control insect pests, such as masson-pine caterpillar, *Dendrolimus punctatus*, ailanthus silkmoth, *Philosamia cynthis*, tobacco budworm, *Helithis armigera*, corn borer, *Ostrinia nubilalis*. The parasitism rates of *Trichogramma* against those pest-eggs mentioned above have reached to 83.36 ±7.78%, 80.44-85.21%, 92.30 ±1.58% and 81.88-86.10% respectively. The artificial host egg-*T. chilonis* have been used to control insect pests, such as sugarcane borers, *Chilo infuscatellus*, *Chilo sacchariphagus indicus*, *Argyroploce schistaceana*, leguminous pod borers, *Maruca testulalis*, pickleworm, *Diaphania indica*, tobacco budworm, *Heliothis assulta*. The parasitism rates of *Trichogramma* against pest-eggs mentioned above have reached to 81.99 ±6.61%, 87.39 ±5.93%, 94.00 ±4.60%, 90.60%, 94.80 ±1.09% and 63.61 ±4.40% respectively. The pratice in controlling 10 kinds of insect pest in total area of 1700 ha indicated that in comparison with natural egg-wasps, the artificial egg-wasps costs much lower when the two kinds wasp have the same effect in control of pest.

#15

THE RECENT PROGRESS OF RESEARCH ON MASS-REARING PARASITIC WASP WITH ARTIFICIAL HOST EGG. Zhicheng Liu, Jianfeng Liu 2, Chungxia Wang, Wuhong Yang (Plant Protection Research Institute, Guangdong Academy of Agricultural Sciences, Guangzhou, China)

This paper reports that the new improvment on mass-rear Trichogramma and Anastatus with artificial hose egg (AHE). 1. The auto-control machine of producing AHE card have been manufactured. 2. The contamination of AHE have been solved. 3. Long time (over 1331 days) store key material of artificial diet successfully. 4. Developing new technique to culture T. minutum and T. pretiosum. with AHE. 5. From 1984-1991, evaluating the effect of inundatirely release Trichogramma and Anastatus which propargated with AHE in 10300 mu sugarcane field and 1500 litchi tree. The control effect is satisfactory.

#16

UTILIZATION OF *TRICHOGRAMMA* SP. FOR THE CONTROL OF INSECT PEST OF RICE AND SUGARCANE IN CHINA. Kai-jia Dai, Ai-hua Cao (Department of Biology, Wuhan University, Wuhan 430072, China)

Utilization of *Trichogramma* for the control of insect pests of rice and sugarcane in more than ten cities and provinces in the south of China has been carried out and the good effects have been achieved. The kinds of controlled insect pests include rice stem borers, *Chilo suppressalis*, *Scirpophaga incertulas*, rice leaf rollers, *Cnaphalocrocis medinalis Parnara guttata*, and sugarcane borers, *Chilo infuscatellus*, *Chilo sacchariphagus indicus*, *Argyroploce schistaceane*. The species of utilized *Trichogramma* include *T. japonicum*, *T. chilonis*, *T. australicum*, T. dendrolimi, T. *nubilale*. In general, the parasitism rates of *Trichogramma* against mass-eggs or eggs of *Cnaphalocrocis medinalis*, *Parnara guttata*, *Chilo suppressalis* in different varcties of rice and *Chilo sacchariphagus indicus*, *Argyroploce schistaceana* in sugarcanes are over 80%. The parasitism rates of *Trichogramma* against other insect pest eggs are 50-80%. The rolled leaves rates, dead-heart rates, dead-sheath rates, white head rates of rice and the dead-hearts rates of shoods, dead-tops rates, bored joints rates of sugarcanes apparently decreased. *T. japonicum* and *T. chilonis* are superior kinds for the control of insect pests mentioned above in rice and sugarcane respectively.

#17

STUDIES ON AERIAL RELEASE OF TRICHOGRAMMA TO CONTROL PINE CATERPILLAR. Xin-wang Tong, Hong ci Liu, Le-xiang Ni, Zhi-gang Xu, Jian-wan Peng, Xian-min Lao(Hunan Institute of Forest Sciences, Changsha 410004, China) Kui-bao Xu(Forestry Bureau of Changsha County 410007, China)Guo-liang Yu(Civil Aviation Office of Hunan Province 410100, China)

Trichogramma, dominant egg parasite of many agricultural and forest pests, has been successfuly exploited to control many a pest at home and abroad. Not only can the method control pests, increase production and influance economic benefits, but also dosen't pollute enviroment, can improve the ecological balance and does no harm to human and livestock. Topography of forest areas is complicated. Besides the incessantly growing trees and enriching ground cover bring difficulty to artificial releasing. Therefore studies on paradroping Trichogramma from telecontrolled airplane and civil plane-Yunwu were conducted. We found that the key to success is that the wasp parapack mast has high capability of catching trees. We devised, through repeatedly try and selection, a kind of semispheral, denticular parapack with 12 teeth. The releasing results demenstrated the rate of catching a tree of masp parapack was 27.88% if 130-200 parapacks were scattered per mu (has relationship to canopy density and survival rate of pine needle). If 30000-40000 wasps were released per mu the percentage of parasitic wasp was 22.70--76.58% and the average rate 44.91% (excluding the natural rate), which increased by 18.23% than 50000 wasps were released. Generally pradrop can reduce cost by 60%.

#18

QUALITY CONTROL OF TRICHOGRAMMA IN MASS PRODUCTION. Yongfan Piao (General Staiton of Plant Protection, Ministry of Agriculture, Beijing 100026, China)

Trichogramma quality is one of key factors which affect results of pest control in field. Major factors, such as a manipulation of the stock parasitoid, ratio between parasitoid and host, time period for stock parasitoid to oviposit, storage conditions for parasited host were studied.

The stock wasps taken from fields maintained the vigour within 6-7 generations, when reared on the eggs of eri silkworm with scattered trays instead of traditional wasp-cards. The optimum ratio between parasitoid and host was 1:20-25 at 25°C, RH 75%. Under above rearing conditions, 76% parasitism, 75.3% emergence rate, 48hr. longevity of adults with a female: male ratio of 5:1 were gained. 40-50 parasitoids emerged from per oak silkworm egg. The emergence rate and the parasitism (stored wasps to fresh egg of oak silkworm) still reached 80% and 72% respectively, after the cold storage for 30 days at 3-5°C, RH 70%.

#19
TECHNIQUES OF PROPAGATING AND RELAEASING TRICHOGRAMMA DENDROLIMI. Cuifu Wang, Dianchen Wang (Station of Plant Protection, Shunyi, Beijing 100026, China)

Since 1976, T. dendrolimi has been continuously used to control the second generation of corn borer. The control areas accumulated were 220 thousand ha. In the early 1980s, using the host egg cards to rear wasps in the chests was changed to utilizing wasp dispersing eggs in the large rooms. In 1986, the techniques was reformed one again, times and the number of releasing wasps were adjusted with the number of pests. When the cluster of eggs reached 0.6–1.0 per 100 shoots, 75 thousand wasps per ha were released and only one time, rather than 450 thousand per ha, three times . The releasing locations were 15 and 45 per ha respectively. The parasitism rate were 56.3 and 69.9% , this result was almost equal to that of 150 and 75 releasing locations per ha.

450–840 thousand wasps per ha were released to control Grapholitha molesta, the parasitism rate was 43.7–86% , the percentages of good fruits of peach and pear were 98.5 and 95.1% . Due to decerasing spraying, the residue of chemicals was declined.

#20
A REPORT ON TRICHOGRAMMA DENDROLIMI—JNYF11 SELECTION. Ying-min Xu You-rong Guan, Fan Zhang, Guang-zhi Sun, Yao-hua Li, Tong Sun, Shu-hong Zhao, Zhi-hong Zheng, Ou-li Wang (Biological Control Laboratory, JiLin Agricultural University, Chang Chun 130118, China)

A good stock of Trichogramma Dendrolimi was discovered when studying the wasps collected from different regions in low temperature treatment. Its developmental duration is 717.4h (15℃), 504h (20℃), 261.7h (25℃), 212.8h (30℃), which are 23.6h, 32h, 49.34h, 25.67h shortter than that of the CT (the local phase) at the above temperatures, respectively. The highest lethal temperature is 40 ℃ (which is 2.5 ℃ higher than that of the CT); it can live 30min at- 25℃ (which is 10min longer than that of the CT). Under the light strength of 180×300LX, the lowest temperature of flying is 17.5℃ (which is 2.5 ℃ lower than that of the CT). The average longevity is 96.6h (which is 25.8h longer than that of the CT). A female adult could oviposit an average of 97.36 eggs (which is 6.8 eggs more than that of the CT). The differences between the stock and other ecotypes are notable with identifying its esterase isozyme and malic acid isozyme by thin layer isoelectric focussing electrophoresis. The method of preserving species was conducted. In 1990, this stock was increased to 39.5 billion wasps, which was released in an area of 17.67 million ha of corn. The number of ostrinia larvae per 100 stalks were reduced by 85% in the field test (which is 10% higher than that of the CT). This stock possesses all characters of a species. It is named as "JNYF11" at the present time.

#21
A STYDY ON TUSSAH EGGS FRESH-KEEPING WITH ^{60}Co-γ RADIATION IN SECOND ORDER REGRESSION ROTATION DESIGN. YOU-Rong GUAN , Ying-min Xu, Fan Zhang, Gunang-zhi Sun, Yao-hua Li, Tong Sun, Shu-hong Zhao (JiLin Agriculture University, Chang Chun 130118, China)

In the second order regression rotation design with three factors ^{60}Co-γ radiation dosage, fresh-keeping time and temperature being decisive variable, the eggs of tussah Antheraea pernyi Guerin-Meneville were divided into 20 groups of different treatments. Then all eggs were parasitized by Trichogramma dendrolimi Mutsumuza at the same time and the percentage of parasitization was tested. There are interaction among these factors. The most important factor is temperature, the dosage is more important than the time. For getting a percentage of parasitization which is more than 85%, the best temperature are those from 5.7–10.2℃, the best time 24–35d, and the best dosage 2.5–10.2Gy. The percentage of parasitization is 63.24%, when the temperature is 27℃ , the time 30d, and the dosage 3×10^4Gy.

#22
RESEARCH AND EXTENSION OF CONTROL OF CORN BORER BY TRICHOGRAMMA DENDROLIMI IN TONGHUA AREA. Jiafan Liu (Tonghua People's Political Consullation Conference, Jilin 134000, China). Muquan Song (Liuhe Agricultural Bureau, Jilin 135300, China)

Tonghua area is located in the Southeast of Jilin Province. Since 1970's, we have been researched and extended to control corn borer by T.dendrolimi in big scale. The results showed as follow: 1) Determing T. dendrolimi as main used species. Though the efficacy of T. ostrinae (87.7%) was better than that of T. dendrolimi (74.0%), its difficult to produce mass of host egg for propagating T. ostrinae. 2) Developing the technique of mass rearing T. dendrolimi and producing 400 million per day. 3) Proposing application techniques in the field. While 1–2 corn borer egg masses per 100 plants was found, it began to release T. dendrolimi. The release interval was 5 days, total 3 times . 225000 wasps per ha were released, and the 1st, 2nd, 3rd releases were 4.5000, 105.000 and 75.000 wasps respectively. There are 40, 000 ha using Trichogramma to control corn borer and good efficacy (75.4–94.1%).

#23
FIELD TRIALS OF MAIZE BORER, OSTRINIA FURNACALIS, WITH TRICHOGRAMMA DENDROLIMI IN BEIJING AREA. Guo-qiang Li (Beijing Municipal Station of Plant Protection, Beijing 100029, China) & Guirong Shi (Miyun Station of Plant Protection, Miyun county, Beijing, China)

With the increase of planting density of maize per ha, traditional application methods of Trichogramma dendrolimi could not meet the ideal effect of the control. The effect of different quantity of T. dendrolimi, date and number of release and number of release points per ha on the control of corn borer, Ostrinia furnacalis, were observed in the field. As a result, 150,000 T. dendrolimi released by two times separatelyat 15–20 points per ha on 24–27th of July could resulted in over 85–95% of parasitization rate, late stage of the second generation and early stage of the third generation of the corn borer were mixed during the period of late July. It is considered critical time of the control by release of Trichogramma especially for summer corn planted in late of June.

#24
ACTIVITY OF SOME SPECIES OF TRICHOGRAMMA (INSECTA, HY) IN ROMANIA. Victor Ciochia, I. Filip, Felicia Muresan, Lorelai Glavan, Lucia Constantin (Academy of Agricultural and Forest Sciences, Lab. Biological Control and Nature Protection, Str. Fundaturii No. 2, RO 2200 Brasov, Romania)

The paper present the results about parasites of some species of *Trichogramma* in order to limit the attack of Lepidoptera. Referring to the fight against Lepidoptera with the help *Trichogramma* it is observed the fact that at sugar beet, maize, cabbage and viticulture, with 2 treatments applied, the mean efficiency obtained between 55-89%, with 3-4 treatments applied at *T. dendrolimi, T. evanescens, T. buesi* and *T. maidis* the efficiency was of 60-96%.

The optimum temperature for the parasites is situated between 18-22^{0}C, when the longevity of adults was bigger.

The treatment with *Trichogramma* spp. was applied during the maximum period of flight of Lepidoptera (*Autographa gamma, Scotia exclamationis, S. ipsilon, S. segetum, Mamestra brassicae, M. suasa* and *M. trifolii*) in sugar beet culture.

#25

CONTROLLING VEGETABLE PESTS BY RELEASING TRICHOGRAMMA AND POLISTIS WASPS. Chunzao Li(Bureau of Agriculture and Husbandry, Yuncheng, Shanxi 044000, China) Tiesheng Li (Institute fo Zoology, Academia Sinica, Beijing 100080, China)

10,000 trichogrammatids per mu each time, 3 times a year were released to control lepidopterous pest in vegetable field. The average parasitic rate was to 55.3-65.5%. For the pest eggs which has not been parasitized and hatched, polostis wasps were used to kill these larvae. 4 nests about 150 polostis wasps per year per mu were released. The lepidopterous pests were reduced by 84.2% compared with the contrast. Meanwhile 13 kinds of natural enemies were increased and the yield per mu had increased by 1,000 kg. Obvious control effect and ecological and economic benifits had been achieved.

#26

A STUDY ON COMPREHENSIVE CONTROL OF CHINESE-PINE CATERPILIAR. Yun-ning Zhou, Jun-sheng Zhao, Mei-li Lian, Xiao-xiu Zhang (Plant Protection Institute, Shanxi Academy of Agricultural Sciences, Taiyuan 030031, China)

The new techniques we have developed to comprehensively control chinese-pine caterpillar (Dendrolimus tebulaeformis) is a set of safe, economy and effective methods. According to its growth habit of spending winter under pine needle at tree's base and going up tree in early April the next year, we dig soil and clear up branched at tree's base in winter, spread insecticide around trunk and tree's base in spring before larvae going up tree, release Trichogramma dendrolimi in summer (mid July to Aug.) when caterpillar is in egg-laying stage, spread insecticide once more in antumn (late Oct.) when caterpillars go down tree. After two year's test and demonstration in Gaofenqu pine woods which has acreage of 1000 mu, percentage of infested tree is decreased from 95% to 0.025% and average population per tree (maximum 725 per tree) is decreased from 324 to 0.019. In 1989, the methods were extended and adopted in more than 80,000 um of pine woods in Shanxi Province, China.

#27

OBSERVATION ON OVIPOSITIONAL BEHAVIOUR OF ANASTATUS JAPONICUS ASHMEAD. Shichou Han, Wenhui Liu (Guangdong Entomological Institute, Guangzhou 510260, China)

Using the eggs of Antheraea pernyi in laboratory, we have observed that the first egg laid by the female wasp was always the female one, the 2nd egg was mostly also the female, 31.67% of the 3rd & 4th eggs were males. 73.33% of the female-parents laid one male progeny. The percentage of the female-parents, laid 2,3 or no male progenies was 16.67%, 5%, 5%, respectively. Only 5% of the female-parents laid 2 male progenies successively. The sex ratio of progenies was 9♀ : 1♂. Females were able to discriminate parasitized host-eggs from unparasitized ones. 81.3% of the host-eggs were parasitized once, and 18.7% of the host-eggs were parasitized twice or more times. The discrimination ability of the females on parasitized host-eggs by the other females was higher than on that by the same female. The time for laying the first egg on host was longer than that for laying the second egg, it was 12min.+18sec. and 5min.+22 sec. respectively. The duration between the 2 oviposition actions was various on different host of on the same host, it was 11 min.+35sec. and 6min.+18sec. respectively.

Anastatus japonicus is the important egg-parasitoid of the lichi stink bug, Tessaratoma papillosa Drury and pine caterpillar Dendrolimus punctata Walker in Guangdong, China. Research on its ovipositional behaviour is useful to its mass production.

#28

INFLUENCE OF TEMPERATURE AND HUMIDITY ON THE LABORATORY POPULATION DYNAMICS OF TELENOMUS THEOPHILAE WU ET CHEN. Pin-nan Chen, Cui Hu, Jia-an Cheng (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

The paper deals with the influence of temperature and relative humidity on the development, survial and reproduction of T. theophilae at six constant temperatures from 18 to 30 °C and five relative humidities from 50 to 90%. The temperature had significant effect on the development and progeny numbers which produced in the first day; but the effect of relative humidity was not significant. The relationship between developmental rate and temperature fitted to the logistic curve. The developmental threshold of males and females were 12.2 and 12.3°C; the thermal constant were 222.2 and 221.2 day-degree, respectively. Four life and fertility tables were constructed and showed that T. theophilae had a great fecundity, high innate capacity for increase. The theoretical stable age distribution of laboratory populations revealed that more than 95% of individuals were immature at all temperatures tested. 24-26 °C, RH 80-90% was the optimal condition for breeding in laboratory.

#29

DEVELOPMENT OF THE PARASITOID, TELENOMUS SP. (HYM., SCELIONIDAE) ON THE EGGS OF FIVE STINK BUGS. Atsushi Kikuchi(Natl. Agric. Res. Center, Tsukuba, Ibaraki, 305 Japan)

Piezodorus hybneri (Gmelin)(Het.,Pentatomidae) is one of important stink bugs on soybean in Japan. Telenomus sp. is the dominant egg parasitoid of the Pentatomid. The parasitoid was reared on the eggs of five stink bug species in the lab and examined which host is the best for massproduction of the parasitoid as biological control agent. 1)Telenomus sp. females parasitized mainly on P. hybneri and Plautia stali Scott eggs, but less than 5% on Nezara antennata Scott, and 0% on Halyomorpha mista (Uhler) and Riptortus clavatus (Thunberg). 2)Developmental period of female Telenomus sp. was 10 days on P. hybneri and 11 days on P. stali at a constant 25°C. 3)The forewing lengths of both male and female parasitoids were longer when emerged from P. stali eggs than from P. hybneri. 4)At 25°C constant, average female longevity was 36 days in adults both from P. stali and P. hybneri with food (50% honey-water sol.), but 4 days in those from P. stali and 3 days from P. hybneri without food. At 7°C, 50% of females from P. stali and 5% from P. hybneri lived longer than 50 days with food. Based on these results, I will discuss the host suitability for massproduction of the parasitoid.

#30

STUDIES ON TELENOMUS (HYMENOPTERA: SCELIONIDAE) SPECIES AND GEOGRAPHICAL DISTRIBUTION IN HUBEI PROVINCE, CHINA. Liang-bing Zong, Chao-liang Lei, Chang-zhen Zhong, Chen-wan Pen (Department of Plant Protection, Huazhong Agricultural University, Wuhan 430070, China)

The species and geographical distribution of Telenomus were investigated in 25 counties of Hubei province, China from 1982--1985. 11 species were identified and 4 species of them were the first records in Hubei, such as T. gefuensis, T. funingensis, T.(A.) closterae, and T.(A.) mondactylus. The species of Telenomus in this area are as follow: Telenomus dignus Gahan, T. rowani Gahan, T. chiloclus Wu et Chen, T. gefuensis Ashmead, T. funingensis Wu et Chen, T. acrobates Giard, T. (Aholcus) monticola Kieffer, T.(A.) euproctidis Wilcox, T.(A.) dendrolimusi Chu, T.(A.) closterae Wu et Chen, T.(A.) monodactylus Liu. This paper also deals with the features of geographical distribution of Telenomus in Hubei province.

#31

THE HOST PREFERENCE AND HOST SUITABILITY OF ANAGRUS NILAPARVATAE PANG & WANG, A MYMARID EGG PARASITOID OF THE RICE PLANTHOPPERS. Zeng-Rong ZHU, Jiaan CHENG and Xiu CHEN (Dept. of Plant Protection, Zhejiang Agricultural University, Hangzhou, 310029, China)

The host age preference by Anagrus nilparvatae Pang & Wang and host age effect on development and reproduction of this parasitoid were studied under constant temperature of 23℃ in the laboratory. The parasitoid has no distinct preference to different ages of eggs of white-backed planthopper (WBPH), Sogatella furcifera (Horváth). But as the age of the host egg increased, the development period of the parasitoid lengthened as well as the body size and fecundity of emerging wasp decreased. The sex ratio and emergence rate of offsprings were not affected by host age. The relationship among the quantitative characteristics of this parasitoid were also discussed and indicated that the larger the body size, the higher the fecundity. A. nilaparvatae obiviously prefered eggs of brown planthopper (BPH), Nilaparvatae lugens (Stål) to WBPH, when both were exposed. Parasitoid size and fecundity were greater in females reared from BPH eggs than in those reared from WBPH eggs. But the parasitoid developmented slowly in BPH eggs. The different combinations of original host and host offered for ovipositing were compared, and found that the females which reared from WBPH eggs were offered with WBPH eggs (WBPH->WBPH), produced fewer progeny than other combinations (WBPH->BPH, BPH->WBPH and BPH->BPH). The rm of the parasitoid of WBPH->WBPH was only 75% of other combinations. It was disccussed that measuring the host suitability to parasitoids by using suitabilty index (SI).

#32

BIOLOGICAL CONTROL OF CORN BORER. OSTRINIA FURNACALIS. Huang Lin, Yong-fan Piao (General Station of Plant Protection, Ministry of Agriculture. Beijing 100026. China)

Ostrinia furnacalis is one of the most important maize peats in China. During the past decades the granules of chemical insecticides were adopted to control this corn borer. It often resulted in pest resistance to insecticides, environment contamination and poison accidents.

Low cost and efficient biocontrol agents, such as Bacillus thringiensis (B. t.). Beauveria bassiana and Trichogramma dendrolimi have been used to control corn borer since 1985. Inundative release of 300.000 Trichogramma dendrolimi per ha. obtained 75% of control effect. In addition, using B. t. granules (4. 5kg/ha) or aerial spray of the B. t. emulsion as well as Beauveria bassiana (B.b.) could lead to over 70% -90% control effect. The total area under the biological control for corn borer was 2. 25 million ha from 1990 to 1991. It was composed of 1.37 million ha of B.t., 870.000 ha of Trichogramma dendrolimi and 120. 000 ha of B.b.. As a result, distinctive benefit of economy, ecology and sociology have been made in these region.

#33

CONSERVATION OF NATURAL ENEMIES IN RICE FIELD. Yu-Chuan Li. Yong-fan Piao (General Station of Plant Protection, Ministry of Agriculture. Beijing 100026. China)

The survey on natural enemies, in 1979-1982 revealed great potentials for control of pests. 1303 species of natural enemies against major rice field pests were identified with results of 56.10% of insecta and 37.56% of arachnida.

Various methods have been taken in the experimtnts and demonstration area for the conservation of natural enemies. The effective and practical means are as follows: Adjustment of economic thresholds; screening pesticides which are of high efficiency, low toxicity and relatively safe to the natural enemies; judicious use of pesticides; better management of fertilizers, irrigations and other cultural activities; collection and transfer of natural enemies; planting secondary crops at the edge of the field etc.. As a result of these practice, the number of natural enemy species such as Paracentrobia andoi, Anagrus sp., Trichogramma spp., and Apanteles cypris etc. increaded by 123% in the pilot and demonstration area, as well as the quantity of spiders reached 1.2 million per ha. increased 4 times than before. Meanwhile, the population of pests, quantity of pesticides applied and the residue in the crop and soil were significantly decreased.

#34

THE DEMOSTRATING AND SPREADING OF NEW PRODUCTIVE TECHNIQUES OF NON-POLLUTED VEGETABLES. Yan-hua Liang, Yang-ou Zhang, Yu-liang Jia(The Plant Protection and Quarantine Station of Linfen Prefecture, Linfen 041000, Shanxi Province, China)

This Paper is the report on demostrating and spreading new productive techniques of non-polluted vegetables. The writers adopted Trichogramma dendrolimi and Bacillus thuringiensis to control cotton bollworm (Heliothis armigera Hubner) and cabbage worm(Pieris rapae Linne)in 7380 ha. of vegetable fields in Linfei region, Shanxi Province from 1985 to 1988. Meanwhile lime sulfur was used to control the red spider and the compound of urea and detergent was used to control the aphid in the vegetable fields. And good results achieved were: the rate of the pests periching exceeded 88.6 percent; examined by the department concerned there were no chemical insectcide remains in the cabbage, chinese cabbage and tomato etc; and 56 species of pest natural enemy were protected and used.

#35

A SURVEY AND STRUCTURAL ANALYSIS ON THE PARASITE'S COMMUNITY OF BOMBYX MANDARINA IN EAST CHINA. Cui Hu, Gong-yin Ye and Xuan-min Wang (Department of Plant Protection, Zhejiang Agricultural Universiy, Hangzhou· 310029, China)

The wild mulberry silkworm, Bombyx mandarina is one of the most important pests of mulberry in China. Through rearing the parasites from over 130,000 eggs, larvae and pupae collected in East China, six species of primary parasites were found, these were Telenomus theophilae, Anastatus sp., Apanteles sp., Brachymeria lasus, Coccygomimus luctuosus and Exorista sorbillans. Percentage parasitism of egg masses, eggs, larvae or pupae was 0-92.22%, 0-56.73%, 0-77.36% and 0-19.57%, respectively. According to the results, Apanteles sp. and Telenomus theophilae were regarded as the superior natural enemies of the pest, and the latter could be widely utilized in practice. In addition, the community diversity and similar coefficient of the parasite's communities in different regions were measured and analysed.

#36

STUDIES ON ANNUAL POPULATION DYNAMICS OF PARASITES OF THE PINE MOTH. DENDROLIMUS PUNCTATUS WALKER. Zhihua He, Ximin Chai (Zhejiang Forestry Institute, Hangzhou 310023, China)

This study was conducted in Quzhou, Zhejiang Province from 1984 to 1986. The results showed that the egg parasitism of the pine moth, Dendrolimus punctatus was highest at the 1st generation and the lowest one at the 3rd generation. The highest pupal parasitism was the 2nd generation, the overwintering generation came the secondand the lowest one was the 1st generation. The egg and pupal parasitism raised with the increase of D. punctatus population density but it related to the population trends of D. punctatus. During the population of D. punctatus was in the declining stage, the kinds of parasites were more abundant and the parasitism was higher. But it was in the initial or raised stage of the population, the sorts of parasites were less and the parasitism was lower. The parasitism was higher at Shang Lin than at Kai Yuansi and Xia Shaxi whether it was egg or pupal stage of D. punctatus. The dominant egg parasites were Anastatus japonicus, Trichogramma dendrolimi and Telenomus dendrolimusi at the 1st, 2nd and 3rd generation of D. punctatus, respectively. The dominant pupal parasites were techina flies. The pupal parasitism was not affected by Decis and Bt.

#37

THE EFFECT OF DIFFERENT HOST DENSITY ON BIOLOGICAL AND ECOLOGIC CHARACTERISTIC OF APHIDIUS GIFUENSIS

Wen-xi Wang(Institute of Plant Protection, Henan Academy Agricultural Sciences, Zhengzhou 450002, China)

The fecundity,reproductive rate,intrinsic rate of increase and functional response of Aphidius gifuensis parasitizing second and third instar nymphs of Sitobion avenae were studied at six different host density under constant tempreture and humidity. The result showed: at the host density of 0, 20, 100aphid supplied to per female parasite per day, the highest number of egg in ovaries are 304.8, 205.3 and 196.4 respectively. At the host density of less than 40 aphids supplied to per female parasite per day, the oviposition was restrained due to the lack of host, the number of egg laid was reduced, the extent of superparasitism increased and the reproductive rate of parasite lowered. When the host density is more than 40 aphids for per female per day, the parasite laid 587.5 egg at most, but the number of aphids parasitized increased with the host density still. The number of aphids unparasitized and the rate of aphids unparasitized increased as the host density went up and the control effect of parasite on the aphid declined. The intrinsic rate of increase of A. gifuensis varied with the host density, the parasite showed that it has a Holling-II type functional response.

#38

BIOLOGY OF APHIDIUS GIFUENSIS ASHMEAD [HEMENO. :APHIDIIDAE].

Yonghong Tang,Yifen Xin (Dalian Animal and Plant Quarantine Service,Dalian, 116001 China)

Studies on some bionomics of Aphidius gifuensis against green peach aphid (Myzus persicae Sulzer) were carried out in laboboratory in 1989-1990.The results showed that 1st,2nd,3rd, 4th nymphs and newly moulted apterous adults were parasitized, and 1st, 2nd instar aphids being parasitized most frequently; The parasitic percentage declined with increase of generations,while there was no significant difference from 1st to 5th generation; Host instar had no effect on progeny's developmental rate of the parasitoid. The optimum temperature for the parastoid multiplication was 25±0.5 ℃ in the study; The parasitoid could discriminate between unparasitized and parasitized host aphids. Slight superparasitism occured on reared aphid population. The result also showed that larves of theparasitoid in the same aphid competed by physiological restraint.

#39

STUDIES ON FECUNDITY OF APHIDIUS GIFUENSIS ASHMEAD. Hong Lu, Zhili Zhang, Baocai Shi (Institute of Plant and Environmental Protection, Beijing Academy of Agricultural and Forestry Sciences, Beijing 100081, China)

Aphidius gifuensis can lay eggs as soon as it emerges from mummy. Its fecundity is 417.5 per female (297-568). Eggs laid by a female per day in Myzus persicae is 47.5. The average life span is 9 days (6-12) and the peak of female's laying eggs is the third day after emerging from mummy. A female can lay 73% of eggs in whole life from the first to the fifth day after emerging. Also, the authors discussed on rearing A. gifuensis in lab and applying to control aphids in glasshouse and the field.

#40

PROTECTING AND UTILIZING NATURAL ENEMIES TO CONTROL THE DAMAGE OF WHEAT APHIDES. Zong_wu Li, Bao_zhen Ren,Li_fang Hou (Shandong Biological Control Experiment Station,Jinan 250100,China), Feng_cai Yang (Yantai Plant Protection Station,Yantai 264001, China)

There are 90 species of natural enemies of wheat aphides discovered in Shandong Province and the dominant species are Coccinella septempunctata Linnaeus,Harmonia axyridis (Pallas),Syrphus corollae Fabricius,Episstrophe balteata De Geer, Aphidius avenae Haliday,and Aphidius gifuensis Ashmead. The occurrence of these three types of natural enemies is one after another and overlapping, so they have higher capacity to control the wheat aphides in the field. On the basis of experiments the utilization index were put: the ratio of effective lady beetle and flies to aphides is less than 1:80, or the rate of ossified aphides parasitized by aphid parasite is about 20%. The protection and use measures were made: (1) Improving planting structure of wheat field to create a suitable condition for living and reproduction of natural enemies. The amount of natural enemies can increase 0.9__5.5 times by interplanting rape or Chinese trumpet creeper in the wheat field. (2) Mastering control index. It is possible not to control of postpone the control when both wheat aphid (600 aphides per 100 plants) and affective amount of natural enemies reach the indes. (3) Applying selective insecticides and improving applaction techniques. When the ratio of useful to injurious insect had became unbalance,it must control to apply 50% Pinimicard wettable powder 8g per mu.The effect of control aphides reaches over 95% without in fluence upon natural enemies. Applying systemic insecticide in low effective dose control effect reaches about 85% and natural enemies protected over 40%. These measures can regulate the ratio of useful to injurious insects to control wheat aphides and got good result in practice.

#41

A STUDY ON THE UTILIZATION OF HABROBRACON HEBTOR (SAY) (HYMENOPTERA; BRACONIDAE)

Xinfei Huang (Wenzhou Animal and Plant Quarantine Service, Zhejiang 325003, China)

Habrobracon hebtor (Say) is a natural enemy of the larvae of Cadra cautella (Walker) and other storage insect pests. In Wenzhou, Zhejiang province, it occurs 13 to 14 generations per year. The life cycle is relatively short as it produces one generation in merely 7 to 8 days during the period from June to October, while its adult is characterized with great longevity and high fecundity (43.3 to 121.3 eggs produced per female on average). Provided that host were plenty, 50 to 60 larvae might be parasited by one fly within one day. In addition, the parasite adult may also prey on the host by sucking its body fluid. Its pupae and adults are resistant to low temperature and can survive for one month at 4-8℃. Adult wasps attack host larvae in the depth of storage grain with average rate of parasitization at 78.7 to 91.6%. It is suggested taht this braconid be released 10 to 15 days after the moth peak of the storage grain pest.

#42

AN IMPORTANT PARASITE OF Aleurocanthus spiniferus (Quai)— Amithus longiconis Foster (Hymenoptera; Serphoidae).

Chang-ming Chen,Zheng-xi Li (Laboratory of Insect Ecology, Hunan Agricultural College,Changsha,410128,China)

Amithus longiconis is an important parasite to the yong nymph of Aleurocanthus spiniferus which had been found in Hunan province in 1989. Their bionomics has been observed in Changsha.There are four generations a year.The emergence period of the parasite adult always followed the hatching period of the host. The female adult of parasite could deposit egg in the first or secondly instar nymph of host. but don't lay egg in the thirdly instar nymph.Each nymph of host only provides for one parasite . although two eggs parasite are lain in one host.More than thirty eggs can be lain by female parasite.At natural conditions,the parasitic rate of four generations of the parasite are 19.6% ,20.5% , 18.5% ,22.1% ,respectively. The highest parasitic rate may arrived at 54% . The searching kairomene of the parasite exists in host honeydew which has been studied on the separation. purification. identification and the effect of host searching kairomene.

#43

INFLUENCE OF TEMPERATURE, RELATIVE HUMIDITY AND NUTRITION ON THE *Cotesia flavipes* (CAMERON, 1891) - *Diatraea saccharalis* (FABRICIUS, 1794) RELATIONSHIP. Parra, J.R.P. (Department of Entomology, ESALO/USP - Cx. Postal 9, 13400 Piracicaba, São Paulo, BRAZIL) - L.E.M. Pádua (Fundação Universidade Federal do Piauí).

This study was carried out to determine the most suitable conditions for mass rearing and release of *Cotesia flavipes* (Cameron, 1891) and to become better acquainted with the host/parasitoid relationship. Temperature markedly influenced the parasitoids biological cycle, which increased with decreasing temperatures. The threshold of temperature and the thermal requirements were determined as well. The fertility of *C. flavipes* was not affected by temperature when it developed under the range between 22 and 30°C. The insect's parasitism capacity was not influenced by temperature and one female parasitized up to three *D. saccharalis* larvae. Relative humidity (under the range between 40 to 100%) did not affect the pupal period, however it did influence its viability and adult life span, which increased with the increase in RH. The nutrition of *D. saccharalis* did not affect the biological development of *C. flavipes* when it developed on larvae reared in different diets. The metabolism of the sugarcane borer was not affected by *C. flavipes* parasitism. The parasitized larvae consumed the same amounts of food as the normal ones. They also gained similar weight and showed similar food conversion efficiencies. The unparasitized larvae showed a higher approximate digestibility than parasitized ones, and the latter digested food with higher efficiency.

#44

Present Status of Classical Biological Control of the Chestnut Gall Wasp, Dryocosmus kuriphilus, by the Introduction of the Parasitoid, Torymus sinensis, in Japan

Seiichi MORIYA[1], Chun-shu PIAO[2], Masakazu SHIGA[3], Kouichi INOUE[1] and Masato MABUCHI[1] ([1]Fruit Tree Research Station, Tsukuba, Ibaraki 305, JAPAN, [2]Research Institute of Pomology, Chinese Academy of Agricultural Sciences, Xingcheng, Liaoning 121600, CHINA, [3]National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki 305, JAPAN)

Ten years have passed since Torymus sinensis was released at the Fruit Tree Research Station (FTRS) in Japan to control the chestnut gall wasp. Recently, the parasitoids have completely suppressed the pest population around the FTRS and their dispersal range presently covers more than 120km from the points of release in 1991 although they are univoltine. Release programs have also been worked out in several main chestnut-producing centers. In the field of the FTRS, the ratio of parasitism per gall was found to be nearly 100% in 1990 even under the very low density of the host population. Laboratory experiments revealed that the number of eggs laid by a female of T. sinensis was 2-3 times as large as that of T. beneficus, a native parasitoid which also attacked the chestnut gall wasp. The successful outcome of the biological control project was mainly ascribed to the superior attributes of T. sinensis.

#45

Effect of Introduced Exotic Parasitoid on Indigenous Ones : A Case Study on *Torymus sinensis* in the Parasitoid Complex of the Chestnut Gall Wasp.

Masakazu Shiga[1] and Seiichi Moriya[2] ([1]National Institute of Agro-Environmental Sciences Tsukuba, Ibaraki, 305 JAPAN, [2] Fruit Tree Research Station, Tsukuba, Ibaraki, 305 JAPAN)

Terms sinensis (*Ts*) introduced from Hobei Province, China, was released in Tsukuba in 1982 and successfully suppressed the chestnut gall wasp, *Dryocosmus kuriphilus* (*CGW*). In the course of this successful case of traditional biological control, several interactions between *Ts* and each of several indigenous parasitoids were observed in the field.

1. Percentage parasitism of *Megastigmus* spp., which are polyphagous but hardly parasitize *Ts*, were suppressed probably due to preoccupation and exploitation of host larvae by *Ts*, because *Megastigmus* spp. attack *CGW* later than *Ts* does.
2. Percentage parasitism of such parasitoids as *Eupelmus* spp. and *Eurytoma setigera* which can facultatively hyperparasitize *Ts*, increased and this resulted in a decrease in "apparent" percentage parasitism by *Ts*.
3. Interspecific hybridization occurs between *Ts* and an indigenous closely related parasitoid, *T. beneficus* (*Tb*), in the field. Percentage parasitism by *Tb* decreased as that by *Ts* increased, and some deleterious effects of cross-mating on *Tb* populations may be expected.
4. There is no evidence to suggest that interactions with indigenous parasitoids are reducing the efficiency of *Ts* as a biological control agent for *CGW* in the field population.

#46

A STUDY ON THE CONTROL OF PISSODES VALIDIROSTRIS GYLL. WITH SCAMBUS SPP.

Shukui Yue, Zhiying Wang, Guocai Zhang (Northeast Forestry University, Harbin 150040, China)

Scambus spp. are superior natural enemies of pinecone weevil in Honghuarji. . The highest natural parasization of pine-cone weevil by Scambus spp. is about 69%. Four species of Scambus spp. are parasites of pine-cone weevil in Honghuarji. They are S. breviconis Grov. (the first record from China), S. punctatus Wang et Yue (new species) and S. eurygenys Wang et Yue (new species).

The control area of P. validirostris by S. spp. amounted to 1766 hectares in 1987-1991. The control result is good. The parasitization was 17.3% higher than control plot. P. validirostris had been reduced an average of 36.3 per tree to an average of 19.1 per tree. their numbers had been controled below threshold (the threshold is an average of 25 per tree). The ecology the bionomic and applying of species of S. spp. are reported in this paper.

#47

CHANGES OF GIANT CELLS AND HEMOCYTES IN THE LARVA OF *CHILO SUPPRESSALIS* PARASITIZED BY *APANTELES CHILONIS*.

San-bao Hang, Zi-qiang Lu (Dept. of Plant Protection, Jiangsu Agric. Colle. Yangzhou 225001, Jiangsu, China)

The results of the studies on the giant cells and hemocytes in the *C. Suppressalis* larva parasitized by *A. chilonis* were summerized as follows:

1. Giant cells were observed only after the *A. chilonis* hatched. On the eighth day, the volume of giant cells was 67 times as much as that of the cells of control group. The relationship between the total giant cell counts (Y: cells / mm^3) and the number of *A. chilonis* (x) in the hosts was shown as

$$y = -66.525 + 12.375x \quad r^{**} = 0.963$$

2. Total hemocyte counts (THC) of the hosts parasitized by *A. chilonis* from parthenogenesis were $2.75-5.00 \times 10^4$ cells / mm^3 higher than those of hosts parasitized by *A. chilonis* from sexual reproduction.

3. On the eighth day after the host lavae were parasitized, the relationship between the THC (Y: $\times 10^4$ cells / mm^3)and the number of *A. Chilonis* (x) in the hosts could be summerized as

$$y = 5.137 + 0.261x \quad r^{**} = 0.828$$

#48

THE ROLE OF BASIC NUTRIENTS IN RELATION TO THE SURVIVAL OF BOLL WEEVIL LARVAE TO THE PARASITATION OF ONE ECTOPARASITOID. Aurora Garza Zúñiga, Antonio A. Guerra, F.A.U.A.N.L., Marín, N.L., U.S.D.A. Weslaco, Texas.

The metabolic patterns of carbohydrate, free amino acid, trigliceride and protein totals in the cotton boll weevil hemolimph Anthonomus grandis Boh. showed high significant differences. In the A. grandis larvae, we found that for the carbohydrates, the higher level was in the third day after the paralization, while for the free amino acids occurred after five days, while three day A. grandis larvae which had been injected with ectoparasitoid venom presented major levels of proteins, while the triglicerides occurred in two days. We concluded that these metabolic processes consisted of very important mechanisms of survival for both, in that the host larvae could maintain an adequate balance of basic automatic nutrients and the benefits of the parasitoid for a vital constant adequate supply over the larvae.

#49

A COMPARATIVE STUDY ON THE BIOLOGY OF *ANISOPTEROMALUS CALANDRAE* AND *LARIOPHAGUS DISTINGUENDUS* IN RELATION TO THEIR HOSTS, *SITOPHILUS ORYZAE* AND *CALLOSOBRUCHUS CHINENSIS*. Mun Il Ryoo and Sang Su Shin (Dept. of Agric. Biology, College of Natural Resources, Korea University, Seoul 136-701, Korea)

To evaluate ability of *Lariophagus distinguendus* and *Anisopteromalus calandrae* to suppress the host populations, *Sitophilus oryzae* and *Callosobruchus chinensis*, a comparative study on the biology of the two parasitoids on the two hosts was studied. *A. calandrae* developed faster than *L. distinguendus* on both hosts. The net reproduction rate and intrinsic rate of increase were also estimated to be higher than those of *L. distinguendus*. Both parassitoids showed significant functional and numerical response (Type II) to the densities of *S. oryzae* and the search rate and handling time were similar to each other. But only *A. calandrae* showed significant responses to the densities of *C. chinensis*. When the two parasitoids were inoculated together at seven density combinations, suppression of *L. distinguendus* by *A. calandrae* was apparent and no progeny of *L. distinguendus* was produced on *C. chinensis*. The results suggested that: (1) *A. calandrae* can be more efficient biological control agent than *L. distinguendus* and (2) interspecific competition between the two parasitoids can be affected by the host species available to them.

#50

Microcharops anticarsiae PARASITOID OF VELVETBEAN CATERPILLAR, *Anticarsia gemmatalis*: HOST AGE PREFERENCE AND SEX RATIO EFFECTS. Prafulbala Navin Patel (Institut of Biology, UNICAMP, Campinas, SP, Brazil).

Host age preference and sex ratio effects were evaluated experimentally in *Microcharops anticarsiae* Gupta, an important natural control agent of *Anticarsia gemmatalis* Hübb. Forty larvae of two consecutive host instars (20/instar) were presented to parasitoid female in choice experiments involving 1st to 4th instar host larvae. Results showed 1st/2nd ($t=0.844$; $p=0.423$) and 2nd/3rd ($t=1.032$; $p=0.324$) instar were equally stung. In the case of 3rd/4th instars although female parasitoids apparently stung more 3rd instar larvae, the differences were not significant ($t=1.886$; $p=0.080$). When all four larval instars were offered together, the 3rd instar larvae were not stung more than 4th instar ($F=1.945$; $p=0.155$). These results indicate that the female parasitoids accept hosts independent of their age. Duration of larval and pupal stages of *M. anticarsiae* did not differ significantly amongst the four host instars; significant differences existed in parasitoid cocoon weight (weighed 24hr after formation) that developed in 1st and 4th host instars. Parasitoid sex ratio was most female skewed in larvae developing in 4th instar hosts (1M : 1.25F).

#51

BIOLOGY AND ECOLOGY OF *ICHNEUMON PROMISSORIUS*, A TRUE PUPAL PARASITOID OF *HELICOVERPA* SPP. IN AUSTRALIA. Cheryl L. Mares and Gary P. Fitt, CSIRO Division of Entomology, Narrabri, NSW 2390, Australia.

Ichneumon promissorius (Erichson), is a true pupal parasitoid of various noctuids in Australia, including the major pest species of *Helicoverpa*, *H. armigera* (Hubner) and *H.punctigera* Wallengren. Studies of the biology, behaviour and field ecology of *I. promissorius* were initiated to assess its impact on pupal populations of *Helicoverpa* and to assess its potential as a biocontrol agent.

I. promissorius is a solitary parasitoid with typical haplo-diploid sex determination. At 25° development from oviposition to adult emergence takes 18-20 days, with males developing 1-2 days faster than females. Females mated almost immediately after emergence and virgins were highly attractive to males. During oviposition a single egg is deposited into any part of the pupa, although about two-thirds were placed in the pupal abdomen. Extensive host feeding on haemolymph exuding from the puncture often follows oviposition. On average each female produced 75 progeny over a lifetime of about 40 days.

In the laboratory there was no avoidance of superparasitism. Each host pupa will sustain the development of only one larva and studies of larval competition involving multiple ovipositions showed that survivors were exclusively female. However in the field, where pupae must be located in the soil, the possibilities for superparasitism are slight. How pupae are located is not yet known.

In the field, *I. promissorius* has been recorded from *Helicoverpa* pupae under a range of field crops during summer and winter, though notably not in maize, a crop which often supports high densities of *Helicoverpaa*. Parasitism by *I. promissorius* is most significant in overwintering populations of *Helicoverpa* under cotton stubble, where up to 20% of pupae may be parasitised. Adults are active through winter and can thus progressively parasitise overwintering host populations. Augmentation of this level of control may be possible if a suitable mass rearing system can be devised.

#52

THE ROLE OF HYMENOPTEROUS PARASITOIDS ATTACKING CITRUS LEAFMINER, PHYLLOCNISTIS CITRELLA STAINTON IN PUMMELO ORCHARD IN PICHIT PROVINCE, THAILAND. Pimolporn Nanta, Rut Morakote, Bungorn Samanakkanee and Surapong Boonyong (Biological Control Research Group, Entomology & Zoology Div., Dept. of Agriculture BKK. 10900 THAILAND).

The survey on hymenopterous parasitoids of citrus leaf miner (CLM), Phyllocnistis citrella Stainton (Lepidoptera: Phyllocnistidae) as well as the study on population dynamics of CLM larvae, pupae and also their mortality by hymenopterous parasitoids were carried out at pummelo growing area in Pichit province, Thailand during 1991. Nine species of parasitoids were found namely, Citrostichus phyllocnistoides (Narayanan), Citrostichus sp., Cirrospilus quadristriatus Subba Roa & Ramamani, Sympiesis striatipes (Ashmead), Closterocerus trifasciatus Westwood, Ageniaspis citricola Logvinovskaya, Kratoysma sp., Teleopterous sp. and Eurytoma sp.
The estimation of percentage parasitism of CLM larvae during May to September were ranged from 25.42 to 91.93.
The population dynamics of CLM larvae and pupae as well as the percent parasitism in chemical insecticide treated and untreated pummelo orchards were compared and discussed.

#53

PRIMARY STUDIES ON THE PARASITIC INSECTS OF LARVAE OF CASMARA PATRONA MEYRICK (LEPIDOPTERA, OECOPHORIDAE) Tiequang Xiao, Huiying Song, Changming Chen (Laboratory of Insect Ecology, Hunan Agricultural College, Changsha 410128, China)

There are four species of insect natural enimies discovered to parasitize the larvae of Casmara patrona Meyrick which is a major insect pest bored in the stem of tea in Hunan province. Their scientific names are as follow: Psen pulcherrimus Bingh (Hymenoptera, Sphecidae), Bracon sp, Macrocentrus linearis (Nees) (Hymenoptera, Braconidae) and Eriborus terebrans (Gravenhorst) (Hymenoptera, Ichneumonidae) The fore two spcies are new record in China and the latter two species are new host record in China. Both their morphological characters, life habits and collected spaces or distributions has been described in the paper. Eriborus terebrans is a dominant species to parasitize the larvae of Casmara patrona at the tea garden in Hunan province. Their natural parasitic rate may reached 11% in Changsha. The next best parasite is Psen pulcherrimus which natural parasitic rate is a little lower than the fore species.

#54

A STUDY ON THE GENUS MICROTERYS THOMSON OF HENAN PROVINCE WITH DESCRIPTION OF A NEW SPECIES (HYMENOPTERA: ENCYRTIDAE). Zhen-ya Shi, Sheng-li Si, He-zhong Wang (Department of Plant Protection, Henan Agricultural University, Zhengzhou 450002, China)

Four species of the genus Microterys collected in Henan province from China are: M. clauseni Compere, M. rufofulvus Ishii, M. kuwanai Ishii and M. didesmococci Shi et Si. Among them M. didesmococci is described as new to science.

Microterys didesmococci, sp. nov.

This species resembles Microterys eulecanii Pilipjuk et Sugojaev and M. clauseni Compere, but may be separated from the former by its ovipositor distinctly extruded, and from the latter by its ocelli in an equilateral triangle.

Length of body: ♀ 2.1-2.5mm; ♂ 1.8mm

Holotype♀, allotype♂, paratype 8♀♀, 1♂, Zhengzhou, Henan, 24, v, 1990.

All are reared by Sheng-li Si from adult females of Didesmococcus koreanus Borchs and are deposited in the Department of Plant Protection, Henan Agricultural University, Zhengzhou, China.

#55

BIOLOGICAL CONTROL OF THE WHITEFLY TRIALEURODES VAPORARIORUM (HOMOPTERA, ALEYRODIDAE), IN GREENHOUSES OF EMBRAPA/CENARGEN. M.R.V. de Oliveira, D.N.M. Ferreira, A. de O. Gerk (EMBRAPA/CENARGEN, Cx. Postal 02372, CEP: 70840, Brasília, DF, Brazil).

Biological control of pests ocurring in greenhouses and quarantine plant houses is an important research area to be developed in Brazil. The use of these houses are increasing exponentially, either to grow crops or for research. The purpose of the post-entry quarantine house is to contain any possible insect outbreak on imported plant material so that a control treatment can be applied. The whitefly Trialeurodes vaporariorum was the most serious pest detected in or greenhouses. It also revealed to be very resistant to the insecticides applied. Host relationship plus density population of T.vaporariorum has been studied. It is an extremely polyphagous insect, attacking a wide variety of crops. Encarsia formosa Gahan has been detected in our screening house and it is showing to be an efficient control agent. Studies on the relationship between the parasitism by E. formosa and host insect are being carried out to develop an effective method to be used in integrated or biological control programmes.

#56

NATURAL ENEMIES OF GYPSY MOTH (LYMANTRIA DISPAR) IN KOREA. R.W. Pemberton, J.H. Lee (Asian Parasite Laboratory. USDA-ARS. c/o American Embassy, 82, Sejong-no, Chongro-ku. Seoul 110-050. Korea), D.K. Reed (USDA-ARS, Stillwater, OK, USA), R.W. Carlson (USDA-ARS, Beltsville, MD, USA) and H.Y. Han (Dept. Entomology. Pennsylvania State Univ., Univ. Park. PA, USA)

Thirteen season-long collections of gypsy moth larvae and pupae were made at seven forest sites near Seoul. South Korea from 1984 to 1989. Season-long parasitism rates ranged from 13.4 to 33.4% and averaged 23.8% overall. Thirty natural enemy species were identified, including 20 species that parasitized 12,388 of the 52,351 larvae and pupae reared during the study. Tachinid, braconid and ichneumonid species accounted for more 99% of this parasitism. with Tachinids being more important than Braconids, which were more important than Ichneumonids. The Branconid Cotesia melanoscelus. which parasitized 24.4% of 1st and 2nd instar larvae. was the most important parasitoid. Parasetigena silvestris (Tachinidae), which parasitized 27.6% of 5th and 6th instar larvae and 36.3% of the prepupae. was second in importance. Blepharipa schineri, a larval-pupal tachinid parasitoid, killed 37.5% of the pupae. The Nuclear Polyhedrosis Virus was the greatest mortality observed in the study, at times killing all of the collected larvae. About one third of the natural enemies, recorded in this study. have been reported in European gypsy moth studies, including 7 species that have been successfully established in the United States.

#57

INSECT NATURAL ENEMY POPULATIONAL DYNAMICS AND ITS CONTROLLING FUNCTION TO PEST IN COTTON FIELD. Ying-jian Zhang, Hui Cang (Institute of Yancheng Agricultural Science, Yancheng 224002, Jiangsu; China), Yun-zhang Han (Plant Protection Station of Dongtai), Da-chang Fu (Plant protection Station of Yancheng)

The insect natural enemy community in cotton field rely mainly on predators. In the groups of predators, the spiders give first place to it; but the dominant species of spiders is not very much, and is vary with seasons and preys.

The mixed population of predators have two fluctuations in cotton growning season. One of peaks appears in second to last ten days of June. and another one after first ten days of Sept. and its low ebb is in Jul. to Aug.. They are coordinative with the pest.

Analyzing from numbers of predator and pest, which are in functional stages, the corelation between predators and pests may be used a relative model as below:

$Y=32404lX^{-2.1658}$ (Y:pest numbers/100 cotton plants, X: predator numbers/100 cotton plants; r=0.9029**)

The corelation between predators and damaged cotton squars and balls may be made a following relative model:

$Y'=4.8028e^{\frac{175.9619}{X}}$ (X:predator numbers/100 cot. pl.; Y': number of damaged squar and ball/100 cot. pl.; r=0.8467**)

#58

STUDY ON THE DEVELOPING TENDENCINES OF INSECT COMMUNITY IN TEA ORCHARD AND INTEGRATIVE PEST MANAGEMENT. Han-gu Zhang (Tea Department of Anhui Agricultural College, Hefei 230036, China)

The ecological environment of tea orchard is stabler and the group of insect community is richer. In China, the tea pests are more than 400 species and its natural enemies more than 500 species. In the natural enemies, many species have natural control effect on pests obviously.

In the present controlling technique of tea pests, it has been overlooked to prevent mostly; while pests developed, some one lays stress on spray medicine consequently , the natural enemies are killed in great number, the community contructure are destroyed, and the natural control on pests of natural enemies are weakened easily. Moreover, different spraying form or seation has related to survival of natural enemies. It should have been adopted to regulate and strengthen cultivative management and winter control, as well as to combine with forest or fruit, then richenning the vegetation in or near the tea orchard, flourishing the insect community, safeguarding the natural enemy resource and increasing the natural control on pests. On this ecological basis, it coordinates biological control, furthermore, reasonable spraying medicine, to result in constituting a better integrative tea pests management.

#59

PRELIMINARY STUDIES OF THE BENIFICIAL ARTHROPODS ON THE GROUND OF APPLE ORCHARD AND THEIR RELATIVE PREDATION . Bai-ge Zhao(Institute of Plant Protection, Academy of Agricultural Sciences, Henan, Zheng Zhou, 450002 China), Yu-hua Yan(Beijing Agricultural University 100094, China)

Experiments were carried out from 1989 to 1990 at apple orchard in Beijing Jushan Farm to provide scientific basis for ground biological control of the peach fruit moth which is one of the major pests on apple tree in northern China. Alfalfa Medicage sativa Linnaeus and bird rapae Brassica campertris L. were intercropped between rows of trees and compared to uncovercropped system. There were 29 species of Spiders, 7 Coleoptera, 4 Hemiptera, 1 Dermaptera and other benificial arthropods on the ground of orchard. Spiders and Carabids were dominant predators. Spiders accounted for 94.74% of total predators by visual search and 12.89% of benificial arthropods by pitfall traps during season. There were significantly more spiders in multiculture system compared with the monoculture, but the densities of carabid beetles in both treatments were of the same level. Significant correlation was found between spider attacking activities on lepidopteran and spider density estimates. Relative predation of arthropod predators on Carposina nipponsis Walsingham was simulated by tied larvae. Result showed that larvae consumption by ground predator accounted for 61.25% of tested food on covercropped treatment which was 1.6333 times over than that of uncovercropped. The roles of ground predators for mantainning orchard ecological balance are discussed.

#60

ON THE RULE OF RESTRICTION OF NATURAL ENEMY AGAINST WHEAT APHID AND CONTROLLING TACTICS. Qing Cao (Gansu Provincial Plant Protection & Quarantine Station, Lanzhou 730000, China)

Sixty-nine species of natural enemy against wheat aphid have been reported in gansu province. The main kinds are ladybird beetle, hoverfly, aphid tion, braconid wasps, stinkbug and spider in wheat fields. The ratio for three main natural enemies respectively are 43.15 percent of ladybird beetl; 40.16 percent of hoverfly and 16.24 percent of aphid lion. The numbr of naturual enemy is increasing atong with expanding of the area of protection and usage of natural enemy in recent years. The benefitial and harmful ratio is controlled within 1:300.

The important measures that have been adopted are follow: winter wheat seeds proper laterly and spring wheat early, while using systematic pesticides as seed dressing. The pesticides are used in wheat growth period until the ratio of aphid-plant reaches to 50 percent, the aphid amount of 100 plants gets to 500, the beneficial and harmful ratio is 1: 150, while no rain in short period. In some areas with good condition, we should help to migrate natural enemy to control wheat aphid.

#61

STUDIES ON THE POPULATION DYNAMICS AND SUPPRESSIVE FUNCTION OF CASINARIA NIGRIPES AT LOW DENSITY OF PINE CATERPILLAR DENDROLIMUS TABULAEFORMIS. Jing-jun Yan, De-fu Yao, Ying-mei Li, Chong-hua Xu (Institute of Forestry, Chinese Academy of Forestry, Beijing 100091, China)

According to the observations in Xishan Area of Beijing in 1985-1991, the population of D. tabulaeformis was in a state of low density successively with an average of 0.4-11.7 larvae / plant. During the past 7 years, the average annual parasitism of C. nigripes was 25.22 ± 11.14%. The parasitism rate was negatively proportional to the host density, $y=34.406-1.909x$, $r=-0.925$. If the parasitism rate was high than 25% in this year, the population density of D. tabulaeformis would lower down in the following year. There was a interspecific competition existing between C. nigripes and Carcelia matsukarehae. The alternate hosts of C. nigripes in the field are Malacosoma neustria testacea, Lymantria dispar and Ivela ochropoda. It has 4-5 generations in a year in different species of hosts. The seasonal population dynamics is like this: its population is more in spring, and it decreased significantly in summer, and it rises again in autumn. According to the observations, it has exerted an obvious suppressive function on the number of D. tabulaeformis at low density.

#62

CLASSICAL BIOLOGICAL CONTROL OF STALKBORERS IN TEXAS. J. W. Smith, Jr. & R. N. Wiedenmann (Department of Entomology, Texas A&M University, College Station, Texas 77843, USA).

Pyralid stalkborers are serious pests of gramineous crops such as maize, sugarcane, rice and sorghum. Our laboratory has been conducting a program for biological control of New World stalkborers, specifically *Diatraea saccharalis, D. grandiosella, D. lineolata,* and *Eoreuma loftini*. The program includes exploration for natural enemies, evaluation of potentially efficacious new association and coevolved parasites, field-release and colonization of parasites, and measurement of the impact of extant and exotic natural enemies on stalkborer populations. In the past 10 years, our laboratory has collected and imported through the Texas A&M Entomology Quarantine Facility more than 60 species of New and Old World parasites, including many new species. Specific research activities include successful colonization of the Old World braconid *Cotesia* (= *Apanteles*) *flavipes*, which has suppressed populations of *D. saccharalis* in sugarcane in the Rio Grande Valley of Texas; field evaluation of the exotic hymenopteran parasites *Pediobius furvus*, *Digonogastra kimballi*, and *Cotesia flavipes* against *D. grandiosella* in Texas maize; and evaluation and initial releases of a new tachinid species (nr. *Lydella*) against *E. loftini* in sugarcane and maize in south Texas.

#63

APPLY TWO KINDS OF ANTIBIOTIC GERMS CURE DENDROLIMUS PUNCTATUS WALKER EXPERIMENT REPORTAGE. Wei-yao Zhang (The Aropical Forestry Experiment Centre of the Academy of Forestry Science of China, Ping Xiang 532600, Guangxi Chnia), Bin-fu Hu (Gui Zhou Provincial Reseach Institute of Forestry, Gui Yang 550005, China).

Recently, The Aropical Forestry Experiment Centre of the Academy of Forestry Science of China apply two kinds of antibiotic germs, Gui Zhou Provincial Research Institute of Forestry has seperatal. Pseudomonas sp and Bacillus cereus Frankland from pine needles of Pinus massoniana Lamt. Being measeured on poisonousness in 1986 experimented on small, plots in forestry in 1987 and experimented on 40ha in 1988. We have verified that the two kinds of germs have good results of prevention and cure to the first generation is 74.55% and 75.08%. The preserving results to the secend generation may reach 50%. At the same time we tested the nine kinds of natural enemy (Linyphiidae spp, Salticidae spp, Oxyopidae spp, Agelenidae spp, Leucauge spp, Mantidae spp, Reduviidae spp, Tachinidae spp, Scymnus sp). The influence gap of is not notable. The experiment is an effective poth of prevention and cure of Dendrolimus punctatus walker.

- Keywords: two kinds antibiotic germs
natural enemy
Dendrolimus punctatus walker

#64

STUDY ON INTEGRATED PEST MANAGEMENT OF POECILONOTA VARIOLOSA (PAYK) (COLEOPTERA: BUPRESTIDAE). Guijing Wang*, Xitang Zhang**, Reizhen Zhao*, et al (Forest Research Institute of Jilin Province*, Changchun 130012, China; Forest Pest Control Station of Baicheng District**)

Poecilonota variolosa is one of major pests of poplar in the north China, which bores trunk and is difficult to be controled as the pest lives in trunk and its generations are overlapping. We have dealt with integrated pest management of P. variolosa since 1986. We have classified forest type according to forest damaged condition, studied the regulation of population alteration. Using $y=-34.67+6.73x$, we can foresee its occurrence time. The optimal sampling size is $N=\frac{1}{D^2}(\frac{2.67}{\bar{x}}+0.24)$. We have proposed a series of integrated management programme to control P. variolosa. We have carried out the programme for 5 years in 12640 ha. and retrieved 1.53 million yuan, which is 8.92 time as much as control cost.

#65

A PRELIMINARY STUDIES ON INOCELLIA SP.-ONE OF THE IMPORTANT NATURAL ENEMIES OF JUJUBE PESTS. Guanglu Shi, Yongliang Fan, Lizheng Li, Meijun Zhao, Jie Li, Guoqiang Yang (Department of Plant Protection, Shanxi Agricultural University, Taigu 030801, Shanxi province, China)

From 1988 to 1990, we found a new species of natural enemies which could control most of the jujube pests in Shanxi Province. The new species was identified by Professor Jikun Yang of Beijing Agricultural University.

Inocellia sp. has one generation a year and young larvae overwinter in the cracks of jujube tree trunk. In the late March of next spring, the larvae begin to feed on the overwintered jujube pests. In the late May, they pupate. The period of pupoe is about 8 days. The adults emerge in the begining of June, then they corpulate in 2-12 hours, after another 5-7 hours they produce eggs. All the eggs are distributed on the tree trunk cracks, rolled leaves and back side of leaves of jujube tree. One female can produce nearly 70-103 eggs. The hatching rate of eggs is 75.7% . Newly hatched larvae eat jujube pests immediately until the middle of November. When the average temperature of 10 days is about 6℃, they begin overwinter.

According to our field investigation and raising in laboratory, we found out that the natural enemy could predate the pupae and larvae of Ancylis sativa and Porphyrinia parva, eggs and young larvae of Sucra jujuba, eggs and adults of Scythropus yasumatsui, larvae of Contarinias sp. and the eggs and nymphes of Ceroplastes japonicus.

#66

ARMORED SCALE EATING LADYBEETLES AND MITE EATING LADYBEETLES IN GUIZHOU AND THEIR UTILIZATION. Xiao-long Yang, Miao-qing Shen, Zhen-zhong Guo, Ji-wen Xiong (Plant Protection Department, Guizhou Agriculture College, Guiyang 550025, China)

Conceptions of armored scale eating ladybeetles and camp of natural enemy are advanced. Guizhou's known species of armored scale eating ladybeetles, mite eating ladybeetles and their camping plants are listed. Chilocorus kuwanae and C. bijugus are dominant species of armored scale eating ladybeetles, Stethrous punctillum is dominant of mite eating ladybeetles in Guiyang. They can migrate among their camping plants with population fluctuation of hosts. Temperature and elevation are main factors affecting geography distribution of armored scale eating ladybeetles. In orange orchard using C. kuwanae and C. bijugus to control Unaspis yanonensis, S. punctillum to control Panonychus citri, each obtains good effects. An IPM plan is put forward to build experimental orange orchard based on protecting and utilizing natural enemies to manage U. yanonensis and P. citri.

#67

A REVIEW ON THE STUDIES OF HARMONIA AXYRIDIS (PALLAS) . Jong-cheng Jiang , Pei-yao Zhu (Institute of Entomology, Jiangxi Agricultural University , Nanchang , 330045 , China)

The Harmonia axyridis (Pallas) , a beneficial ladybird beetle is divided into two systems with its colour pattern of elytra: the yellow background and black background type. The type which is yellow on the front half part of the elytra and black on the hind half part is rarely existed in the natural group , it is a transitional form of this group . The population of two types are clined gradually from northeastern and northern part to southern and southwestern part of China . The transverse ridgetrace of Harmonia axyridis (Pallas) on the hind part of elytra is a important feature to distinguish from the other ladybird beetles , but some indiduals are without this ridgetrace in the natural or raised groups in a proportion. The distribution and feeding habits and its characteristics of the overwinter forms of this ladybird beetle in southern and northern China are summarized in this paper . The rock holes and scams are the overwinter places in north as a reservoir of this ladybird beetle . To raise this ladybird beetle in the holes and scams with artificial food before and after the overwinter period is proposed in the first time.

#68

STUDY ON THE RESISTANCE TO STARVATION AND THE DORMANT TEMPERATURE OF Harmonia axyridis Pallas. De-wen Cui, Yue-ge Huang, Shu-shen Shi, Shu-qin Yan(Jilin Agricuttural Univercity, ChangChun 130118, China)

Harmonia axyridis Pallas is a maijor natural enemy of aphid and scale in Jilin Province. This experiment was carried out during 1989-1991. The aim is to protect H. axyridis Pallas and build up a theory which help people to migrate these benifit insects to control pests. The experiment was done on a base of investigation on the H. axyridis Pallas's population and its dormant way.

There were two temperature treatments in the dormant period. Thay are 0℃ and 4℃ (R.H. 85% and wood dust were put in the container with the ladybirds together). By the end of 6 months (from early October to early Aprit next year) , the survival rates are 36.5% and 49.5% respectively. These figures are significantly greater than that under the natural conditions (18.2%). To determine the resistance to starvation, the ladybirds collected from caves were kept in a temperature cabinet, in which the temperature is 20℃ and R. H. is 75%. H. axyridis Pallas is treated in three ways. They are feeding without water, with water and with glucose solution. The survival rates are 50.8%, 87.5% and 87.7% respectively by the end of 10 days. They are 13.1%, 42.4% and 78.4% by the end of 20 days, respectively, and 0.7%, 7.5% and 69.8% respectively by the end of 30 deys. They are feeding water and glucoss solution. The survival rates are 1.7% and 66.5% respectively by the end of 40 deys. The dormant temperature and the resistance to starvation of H. axyridis Pallas may relate to its physic state and the ecological niche. So the further study about these shoud be done.

#69

ABUNDANCE OF COCCINELLID PREDATORS IN SELECTED VARIETIES OF COWPEA INFESTED WITH APHIS CRACCIVORA KOCH (HOMOPTERA: APHIDIDAE) IN NIGERIA. Ofuya, Thomas I. (Department of Crop Production, The Federal University of Technology, P.M.B. 704, Akure, Nigeria)

Abundance of coccinellid predators in some varieties of cowpea (Vigna unguiculata (L.) Walpers) known to be resistant and susceptible to the cowpea aphid, Aphis craccivora Koch, was observed in 1989 and 1990 in Nigeria, under artificial infestation by the aphid. Highest aphid densities were developed in the susceptible varieties. Coccinellid predators were also more abundant in the susceptible than in the resistant varieties except IT84S-2246-4. The suitability of crop varieties such as IT84S-2246-4 in integrated pest management is highlighted.

#70

EXPERIMENTS ON CONTROL OF APHIDS BY LADY BEETLE LEIS XYRIDIS. Rongcai Yuan, Xiangwei Meng, Yarong Bi (Tonghua agricultural Institute, Jilin Province 135007, China)

Experiments on biology of lady beetle, leis xyridis and collection, breeding of overwintered adult and releasing of new hatched larva to control aphids were carried out in 1987-1990. Results are as follows. The favourable temperature for breeding adult was 23℃-25℃. Under 23℃, a total of 734.6 eggs were deposited per female and 19.4 eggs (0.91 egg masses) were deposited per day 1 female. The new hatched larva had a motionless period for 0.5-1 days. Duration of larva was 8-10.3 days. In the condition of 9-15℃ , the egg duration was 12-15 days, egg hatch ability was 83-88%. Without aphids the first stage larva can disperse 0.9 metre during 24 hours.

Releaseing for control of soybean aphid was conducted in 1988 and 1989. A total of 3000 new hatched larva was released per mu. Ten days after released, compare to the un-released field, the aphid populations were decreased for 93% and 95% respectively. 480 adults were collected on 2-3 June, 1990. There were 5200 masses of egg deposited during 56 days. All the new hatched larva were released separately into the fields of soybean 2 mu, maize 3 mu, vegetable field 0.3 mu and 5 fruit trees. The aphids population were controled. By the wey, released the new hatched larva into the fields every day, to avoid the larva eated each other when mass breeding gave good results. Baseed on the results, we suggested collection and breeding overwintered beetles in spring, then separately release the new hatched larva.

#71

FEEDING BEHAVIOR AND REPRODUCTION OF *DELPHASTUS PUSILLUS* (COL.: COCCINELLIDAE) ON THE SWEETPOTATO WHITEFLY. K.A. Hoelmer (USDA, ARS, 2120 Camden Rd., Orlando, FL 32803), L.S. Osborne (Univ. Florida, CFREC, 2807 Binion Rd., Apopka, FL 32703), and R.K. Yokomi (USDA, ARS, 2120 Camden Rd., Orlando, FL 32803).

The feeding behavior, development, reprodnction, and longevity of *Delphastus pusillus* (LeConte) feeding on *Bemisia tabaci* (Gennadius) was observed in the laboratory at 28 degrees C. Development time from oviposition to eclosion was 21.0 days. Longevity of adults was 60.5 days for females and 44.8 days for males. Larval and adult beetles fed on all stages of whitefly. Daily consumption of prey by adult beetles was dependent on age of prey, from 167.1 eggs to 11.6 young 4th instars. Time required to consume prey was directly correlated with stage of whitefly, from 31.3 seconds for eggs to 377.7 seconds for young 4ths. Larval beetles began feeding upon hatching and consumed 977.5 eggs before pupating. Mated females laid eggs only when reared on diets containing whitefly eggs. Between 100 and 150 eggs per day were required to initiate and sustain oviposition. When reared exclusively on egg diets, beetles laid 3.0 eggs per day. Mean lifetime egg production was 183.2. The requirement for a diet high in whitefly eggs suggests *D. pusillus* will maintain itself without augmentation only in large populations of *B. tabaci*.

#72

EFFECT OF METHYL EUGENOL TRAPS ON THE POPULATION OF THE LACEWINGS, ANKYLOPTERYX OCTOPUNCTATA (NEUROPTERA: CHRYSOPIDAE)

K. Charernsom and W. Suasa-ard. National Biological Control Research Center, Kasetsart University, P.O. Box 9-52, Bangkok 10900, Thailand.

The population fluctuation of the lacewings, Ankylopteryx octopunctata (Neuroptera: Chrysopidae), was investigated in two locations, one at Rayong province in eastern part of Thailand and another one at Nakhon Si Thammarat province in the southern region. In each location ten traps of methyl eugenol were set and the insects collected at two weeks interval for one year. The highest peak of the lacewings population at Rayong was in December and in Nakhon Si Thammarat was in June. It was noted that in both locations the numbers of the lacewings catched were higher than those of fruit flies collected at the same time. The data obtained raised a serious question whether the methyl eugenol trapping could be detrimental to predator population, the chrysopid in this experiment. The total number of the lacewings collected in this investigation was 13,597.

#73

TOLERANCE TO FOOD SHORTAGE IN MALLADA ALCESTES (BANKS) (NEUROPTERA : CHRYSOPIDAE). Takashi Kubota, Division of Entomology, National Institute of Agro-Environmental Sciences, Kannondai, Tsukuba, Ibaraki, Japan 305.

To examine the development and survival of a chrysopid, M. alcestes, larvae were reared individually on eggs of Tribolium confusum in the laboratory. Eggs of T. confusum were stored at 5°C, and used without any other particular egg killing treatment.

When M. alcestes were given a sufficient amount (ca. 40mg) of food eggs refrigerated for 6 weeks, they emerged as adults without additional supply of food eggs. But when the same amount of food eggs refrigerated shorter than 6 weeks was given to M. alcestes, many chrysopids stayed at the 3rd instar for a long period and died without forming cocoons. When refrigerated only for a short period, some eggs of T. confusum hatched and preyed on each other. This possibly brought about food shortage to M. alcestes. Most 3rd instar larvae of M. alcestes, initially given food eggs refrigerated shorter than 6 weeks, could survive to adults when additional food was supplied. A similar phenomenon was observed when chrysopids were reared on old eggs of T. confusum, i.e. refrigerated longer than 6 weeks. These chrysopids, including those reared on old eggs, had a longer adult body length and total developmental period (T.D.P.) and smaller coefficient of variation of T.D.P. than did those reared on most suitable food, i.e. eggs of T. confusum refrigerated for 6 weeks.

When food supply is short, 3rd instar larvae of M. alcestes appear to be able to tolerate food shortage for an extended period. When additional prey are found, the larvae resume development and become bigger adults than those which have matured quickly under sufficient food conditions. This may be related to the predaceous habit of this insect.

#74

ANTHOCORIDS OF GEN. ORIUS AS AN PREDATORS OF FRANKLINIELLA OCCIDENTALIS (THYSANOPTERA; THRIPIDAE) IN THE CANARY ISLANDS.* Carnero Hernández, Aurelio (C.I.T.A., Apartado 60, 38080 La Laguna, Tenerife, ISLAS CANARIAS); Peña Estevez, M.A. (Granja Agrícola Los Moriscos, Las Palmas de Gran Canaria); Pérez Padrón, F. (C.I.T.A.); Hernández García, M. (Servicio Defensa Cultivos, Tenerife).

Frankliniella occidentalis (Pergande) is a pest which produce big losses in horticultural and ornamental crops in Canary Islands (sweet pepper, tomato, rose plantations, etc...). Population of different species of Orius were monitored on field. We had founded four: Orius albidipennis, Orius limbatus, Orius laevigatus and Orius sp. (Lindbergi). They live on same host plants. We has made a breeding of differents species of Orius on Anagasta kuehniella and Anagasta cautella (Lepidoptera, Pyralidae) for essay the predation-degree on F.occidentallis. Until the results are not enterely defined.

(*) This research is supported by Ramón Areces Foundation

#75

A STUDY ON THE FAUNA AND BIONOMICS OF SYRPHIDS IN WHEAT FIELD. Cheng-ze Yang, Yun-zhuan He, Jun Ding, Ling-xiao Kong, Teng-wu Li. (Department of Plant Protection, Hebei Agricultural University, Baoding 071001, China)

The present paper records the result of author's research about the fauna of wheat-field and the bionomics of predominant species of syrphids in Hebei province from 1982 to 1988. Through investigations 8 genera 15 species are obtained in the wheat-field, out of which there are five predominant species of different periods: Epistrophe balteata De Geer, syrphus corollae Fabricius, Sphaerophoria scripta L., Syrphus nitens Zetterstedt and Lasiopticus pyrastri L.. In the wheat-field of Hebei, syrphids appears from early March to early and middle June, and the peak period of its larva is usually 3 days later than that of grain aphids, which has good control effect on grain aphids. The average larva feeding aphids per day is 88.7-132.6. Under the constant laboratory conditions the developmental periods of one generation needed by predominant species are 28-31 days, and the developmental period of egg. larva and pupa are 3-5, 8-10, 7-10 days, respectively. The seasonal variation of populations, adult's characters, habits, sex ratio, natural enemies and thresholds of development of some species are also given in this paper.

#76

THE RECORDS ON THE NATURAL ENEMIES RESOURCES OF COTTON PEST IN HEBEI (I) (HEMIPTERA). Chun-sheng Miao(Cangzhou Agricultural Research Institute, Cangzhou, Hebei, 061001, China)

The present paper deals with a preliminary study on natural enemies (Hemiptera) resources of cotton pest collected in Hebei province during1978 to 1990. The species, hosts and distribution area are given details in this paper. eighteen species, representing six families of natural enemies of cotton insects are found in this area. Six species: Ara custos(Fabricis), Nbis sindforus Hsiao, Orius minutes Linnaeus, Daraeocori punctulatus Fall, Crytonhinuo liyiclipennis Reuter and Geocoris pallidipennis (Costa) were the predominant species.

#77

UTILIZATION OF EOCANTHECONA FURCELLATA (WOLFF) (HEMIPTERA:PENTATOMIDAE) FOR AUGMENTATIVE BIOLOGICAL CONTROL OF INSECT PESTS OF FIELD CROP IN THAILAND. W. Suasa-ard and K.Charernsom. National Biological Control Research Center, Kasersart University, Bangkok 10900, Thailand.

Utilization of pantatomid predator Eocanthecona furcellata (Wolff) (Hemiptatera: Pentatomidae) for augmentative biological control of insect pests of field crop especially, Achea janata (L.), Heliothis armigera Hbn., Spodoptera litura L. and many other species of leaf eating caterpillar was carried out in the laboratory and supplemented with investigations under field condition at Nakhon Ratchasima, north-east of Thailand. The investigation included various aspect on biology, ecology and mass rearing of E. furcellata and assessment of efficiency of E. furcellata. It's revealed that E. furcellata could multiply about 15 time in each generation and about four months after inoculative release the population of E. furcellata well developed and increased to the higher levels than those of the unreleased plot and E. furcellata showed satisfactory evidence of control over the population of those insect pests. The investigation indicated that E. furcellata was very important biological control agent for augmentative biological control of those insect pests of field crop in Thailand.

#78

LABORATORY OBSERVATION ON DEVELOPMENT AND PREDATORY ACTIVITY OF Toxorhynchites splendens WIEDEMAN (CULICIDAE) LARVAE. SASTRODIHADJO S., A. HIDAYAT., A.D. PERMANA. (Inter University Center-Life Sciences-ITB, Ganesha 10 Bandung 40132 Indonesia).

Larvae of Toxorhynchites splendens are predaceous on small aquatic invertebrates, mainly mosquito larvae. They are considered potentially as a biological control agent for mosquito vectors of human disease. The effects of temperature ond development and predatory activity of T. splendens larvae against Aedes aegypti larvae were observed at laboratory conditions. Increase in temperature caused more rapid larval development time, and increase in daily predation. Under 22, 26 and 30°C, the daily predation were 62.9, 72.3 and 73.5 prey/day and the larval development time were 24, 15 and 13 days respectively. Interaction beetwen temperature and prey density seems to influence the daily consumptions.

#79

THE RESEARCH ON THE ABILITY OF MACROPODUS CHINENSIS TO PREY ON MOSQUITO LARVAE AND ITS TOLERANCE TO TWO PESTTICIDES (DIMETHOATE, MALATHION). Jie Zhou, Xian-wu Guo (Department of Fisheries, Huazhong Agricultural University, Wuhan 430070, China)

Macropodus chinensis is a small-sized, omnivorous,freshwater fish. It prefers to feed on wigglers and chironomid larvae rather than feed on Rotifera, Cladocera, Copepoda, and their food elective indexes are upward of 0.9. Being in full state, it preyed upon 206.7 wigglers per day in average while in hungry state 305.6. The number of wigglers in paddy-fields decreased separately by 80%, 85.7%, 100%, as the fish was put in paddy-fields by the density of 0.5, 0.75, 1 individual/m^2, respectively, before one month. M. chinensis has fairly strong power of tolerance to toxicants. At a water temperature of 22±1℃, the 48hr LC50 of dimethoate and malathion to the fish was estimated to be 26.29 and 1.93ppm. From the above, it can be concluded that M. chinensis is a fine, wiggler-killing fish.

#80

OBSERVATION ON BIOLOGICAL CHARACTERS AND APPLIED EFFECT OF LYCLOCRIS SP. Xiangxing Zeng, (Huaihua Grain School, Hunan 418000, China)

The Lyclocoris sp. is a predatory insect which belongs to the Brachypteridae. There are 2-3 generations a year and about 60-70 days one generation. The adults begin to breed from the late April to early May. The habits of adult deposited eggs, the periods of egg and larvae, and the suitable temperature and relative humidity for their development were observed. This predator is a good natural enemy to control larvae and eggs of some pests in grains storehouse, such as: Tenebrio obscurus, Sitophilus zeamais, Callosobruchus chinensis, Bruchus rufimanus, B. pisorum, Carpophilus dimidiatus, C. ferrugineus, Rhizopertha dominica, Lasioderma serricorne Ahasverus advena, Palorus ratzeburgi, Tribolium castaneum, Sitotroga cerealella, etc. The adult can captures 21 eggs and larvae of the preys indoor, but don't captures their pupae. Two experiments to test the effect of Lyclocris sp. were carried out in five grain storehouses in Dong Dao County. The results of first experiment showed that the pests densities declind from 65/kg to 5-19/kg in the treatment with predator. Next results showed that the pest population density declined obviously, i.e. Sitophilus zeamis from 21/kg to 2/kg, Cryptelestes pusillus form 25/kg to 2/kg, Cryzaephilus surinamensis and Sitotroga cerealella were died fully, so that the Cyclocris sp. is an effective natural enemy for storage pests control.

#81

THE ROLE OF DOMINANT ARBOREAL ANT SPECIES (HYMENOPTERA, FORMICIDAE) AS BIOLOGICAL CONTROL AGENTS OF THE CATERPILLAR *ACHAEA CATOCALOIDES* GUENEE (LEPIDOPTERA, NOCTUIDEA) IN COCOA PLANTATIONS OF CAMEROON.

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In tropical agro-ecosystems, dominant species of ants are generally considered as important biological control agents. Nevertheless, until now, very few quantitative studies have been conducted to precisely estimate their role in protecting cultivated trees. In Western Africa, the caterpillars of the butterfly *Achaea catocaloïdes* are polyphagic phytophageous insects that especially attack cocoa trees they can entirely defoliate. This study was carried out in Cameroon (80 km South from Yaoundé), mainly in two neighbouring plantations, during the period of maximum proliferation of this pest. The first plantation, highly occupied by *Tetramorium aculeatum*, was scarcely attacked whilst the second one, where the ants were very few, was heavily defoliated. The study of the impact of the presence on the trees of the three dominant species of ant, *T.aculeatum*, *Oecophylla longinoda* and *Crematogaster depressa* shows a beneficial effect in comparison with unoccupied trees. The respective impacts of *T. aculeatum* and *O. longinoda* are very similar, the latter being however more advantageous. Partial results concerning a single colony of *Crematogaster* show that this species is less efficient in protecting cocoa trees than the two other dominant ants.

#82

STUDIES ON THE FOREST ANTS AS A CONTROL AGENTS FOR DENDROLIMUS PUNCTATUS WALKER. kwankai Liao (Chongqing Municipal Institute of Gardening and Afforestation, Chongqing, China)

Dendrolimus punctatus Walker are the most serious pests on forest trees in our country. Polyrhachis divee F. Simth and Crematergaster artifex Mayr can control the pests effectively and they have enhanced the biological control in the forest ecology system. They also have increased the proportion of benefit insects to pests. These two ants are therefore effective biological control agents for Dendrolimus punctatus Walker.

#83

ACARINE FAUNA IN THE NON-SPRAYED JAPANESE PEAR ORCHARD. Hiroshi Amano (Faculty of Horticulture, Chiba University, Matsudo, Chiba, 271 Japan)

Acarine fauna both on Japanese pear trees and on ground covers was investigated in 1986 to 1988 in the orchard(cv. Nijisseiki) located in the central region of Japan. Main purposes of the study were to search for potential biological control agent(especially predacious phytoseiid mites) against harmful mites, as well as to characterize phytophagous mite fauna free of pesticide-originated selection factor in this region.

Although a slight modification of mowing practices existed depending on the study year, a rust mite species (Eriophyes chibaensis Kadono) was a only predominant phytophagous mite on the pear tree throughout the research period. Responding to this prey mite, predacious phytoseiid species such as Amblyseius sojaensis Ehara, A. eharai Amitai & Swirski, A. okinawanus Ehara and Typhlodromus serrulatus Ehara showed their abundances on the tree. On the other hand, some Tetranychus species appeared with relatively low densities on ground covers, accompanied with several phytoseiid species as A. okinawanus, A. orientalis Ehara, A. eharai and A. tsugawai Ehara. In January 1987, a pear tree was cut down and every crevice on the twigs, branches and trunk were examined under a stereoscopic microscope in order to observe overwintering phytoseiid mites. Only a few individuals were found which incidentally were adult females of the genus Typhlodromus.

#84

EFFECT OF SUBLETHAL CONCENTRATION PESTICIDES ON THE EGGDEPOSITION, HATCHING AND SETTLEMENT OF PHYTOSEIULUS PERSIMILIS (ACARI:PHYTOSEIIDAE) Huifang Dong, Yu-jie Guo and Junhua Zhao (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

Effects of six pesticides, hexythiazox (50ppm) , flufenoxuron (50ppm), amitraz (2ppm), pyridaben (200ppm), biphenthrin (0.2ppm), and cyhalothrin (0.05ppm) at sublethal concentrations (LC 0-13.8) , were tested on the egg-deposition, hatching and settlement of P. persimilis using bean leaves infested by spider mites. In laboratory, hexythiazox and flufenoxuron had no harmful effect on egg-deposition and hatching. Comparing with the control, amitraz reduced two third of the hatching but no effect on the egg-deposition, pyridaben, biphenthrin and cyhalothrin reduced egg deposition by 34.9%, 21.8% and 18. 0% , respectively.

In the greenhouse test, the treatment of potted bean plants infested by spider mites with hexythazox, flufenoxuron and amitraz, did not show any different effect on the settlement, but pyridaben, biphenthrin and cyhalothrin significantly affected the settlement of P. persimilis. In control, the settlement was 85%, but it was only 25% on bean plants treated by pyridaben and zero by either biphenthrin and cyhalothrin. It is noticed that sublethal concentrations of hexythiazox and flufenoxuron were just the same as concentrations of these two pesticides recommended for control of spider mites and so they may be considered as safe pesticides for the IPM of spider mites. However, the harmful effects of amitraz, biphenthrin and cyhalothrin were observed on the establishment of population of the predacious mite even at the concentration diluted to 0.1-0.5 million times. Therefore, the authors consider that these three pesticides may not be good to be used in IPM of spider mites.

#85

STUDIES ON CONTROLLING APPLE RED MITES BY USING PREDATORY PHYTOSEIID MITE *METASEIULUS OCCIDENTALIS*. You-guang Chen, Chun-hua Wang, Hui-xie Wei, Qiang Zhu, Zhi-hui Du, Zheng-an Chen (Shaanxi Institute of Fruittrees, Yangling, Shaanxi 712100, China)

This artiele introduces the results obtained in the researeh on *Metaseiulus occidentalis*. Works done in this aspeet include; making observations of the developmental stages; eating habits and the characteristics of *Metaseiulus occidentalis* after their being introduced to Shaanxi Province; carrying out releasing tests on them; solving the problems of their surviving winter safely; determining the insecticide-resistanee of *Metaseiulus occidentalis* and its utilization and using them in integrated eontrol of inseet pests and diseases in the western arid areas of China.

#86

BIOLOGICAL CONTROL OF SPIDER MITES ON GERBERA. Kropczynska D., Tomczyk A. /Department of Applied Entomology, Warsaw Agricultural University, 02-766 Warsaw, Nowoursynowska 166, Poland.

Experiments were conducted on eight cultivars of Gerbera with different levels of two-spotted spider mite /Tetranychus urticae Koch/ infestations. On these plants the density of spider mite populations varied depending upon cultivar from 10 to 70 mites per leaf. The most susceptible cultivar for spider mites was Hanny. Four cultivars: Comaro, Raisa, C, Playa, and Amazon manifested low levels of susceptibility. Phytoseius persimilis /A.-H./ was introduced in weakly intervals during the first three weeks of the experiment, 17 predators per m^2 in total. On a majority of tested cultivars spider mite populations were reduced by predator during 6 weeks. Only on cultivar Hanny the introduced population of Ph. persimilis was not sufficient to reduce the number of spider mites to a low level during this period.

#87

EFFECTS OF TEMPERATURE ON THE LIFE HISTORY OF A SPIDER, MISUMENOPS TRICUSPIDATUS (ARANEAE: THOMISIDAE) AND ITS CONTROL OF PESTS IN COTTON FIELDS. Jing-zhao Zhao, Dai-qin Li (Institute of Pest Natural Enemies, Department of Biology, Hubei University, Wuhan 430062, China)

Effects of six constant temperatures(15°C, 20°C, 25°C, 28°C, 30°C and 32°C) on development, mortality, fecundity, fertility, and longevity of M. tricuspidatus in Wuhan, China, were examined in lab. Under a constant temperature of 35°C, the eggs of this spider can not hatch. The duration shortens graduate with the rising of temperature between 15°C and 32°C. Optimum temperature for development and reproduction within the examined range is 25°C. From 25°C to 30°C, the survival rate of spiderlings is higher than under any other temperatures. The fecundity is the strongest at the constant temperature of 30°C, while the fertility of this spider is stable at the level of species. Based on regularity drawn from experimental data, the mathematical models of effects of temperature on the developmental rate were established, and the life table of the spider under six constant temperatures in lab was set up. The functional response of M. tricuspidatus to the larvae of its prey, Heliothis armigera, was studied in lab.

#88

STUDY ON INTERACTION RELATIONSHIP BETWEEN SPIDER AND PLANTHOPPER, AND ITS UTILIZATION. Hongquan Wang, Hengmei Yan, Haiming Yang (Department of Biology, Hunan Normal University, Changsha 410006, China)

The rice brown planthoppers Nilaparvata lugens Stål are major insect pests of rice plants. Rice field spiders are major predaters of planthoppers. We set about study on correlation between planthoppers and spiders, and the experiment of conservation and utilization of spiders in Hunan province and other place of China during 1975-1990. The pupose is to provid new agents of IPM. The results showed that the species of rice field spiders are much in quantity, and also in the quantity of reproduction. It is similar that was found the population changes, habitats and metamorphosis of the life history of both planthoppers and dominant spiders species. The interaction relationship of the spiders and planthoppers is significant. The spiders increases year by year through the conservation of them, and so do other natural enemies. Consequently, the function of getting various kinds of natural enemies united against the planthoppers is full displayed. The spiders conservation program was started on a 23 mu rice fields in 1976. By 1984 it had extended total 37 million mu in Hunan and other six provinces, and by 1988 developed about 24 million mu in Hunan only.

#89

FORAGING BEHAVIOUR OF MULTI-PREDATORS FOR CITRUS RED MITE. Qingcai Wei, Zhimo Zhao, Lungshu Li (Dept. of Plant Protection, Southwest Agric. Univ., Chongqing 630716, China)

The foraging behavior of four predators (Stethorus chengi, Agistemus extsertus, Amblyseius nichols, A. vulgaris) for citrus red mite Panonychus citri was invesitgated, as well as how the interference inter and intra species occurs, by using the rotational composite design of quadratic regression. The predation model of the four predators to mites was obtained: $Y=13.7569+1.4583P_1+0.3750P_2+0.3750P_3+0.125P_4+11.0417X-0.0625P_1P_2-0.1875P_1P_3-0.0625P_1P_4+0.8125P_1X+0.8175P_2P_3+0.3125P_2P_4-0.0625P_2X+0.1875P_3P_4+0.0625P_3X+0.1875P_4X-0.6354P_1^2-0.3854P_2^2-0.0104P_3^2-0.0104P_4^2+3.4896X^2$. The principal efficiency analysis on this model indicated that increase of the mite density has significantly increased the predation of predators on the mites and the affection is greater than that of any predators. Among the four predators, the increase of S. chengi density has the greatest affection on the increase of predation, A. extsertus the second, A. nichols the third and A. vulgaris the weakest. As the predator density increases, the interference inter and intra species occurs, which is largely related to the size, activity, and searching efficiency of the predators. S. chengi has the greatest interference between different individuals and with any other predator species, and A. extsertus the second, which reduced the predation in high predator densities. However, A. nichols and A. vulgaris have little interference in the densitites, they even promote each other and increase the predation as the densities of the two predators increase. Besause of these, the highest predatism were obtained in the prey density of 30 and the optimal proportion of the four predators in the multi-predator prey system were 3.65:1.92:1.36:1.45.

#90

INDUCIBLE ANTIBACTERIAL AND LECTIN ACTIVITY IN HEMOLYMPH OF CHRYSOMYIA MEGACEPHALA LARVAE AND PUPAE. Xiao-dong Wang, Qing-sheng Jin(Institute of Biology, Hebei Academy of Seiences. Shijiazhuang, 050081, China)

It is well known that a transient baeterieidal aetivity can be induced in the hemolymph of many inseet larvae and pupae by vaccination with homologous or unrelated baeteria, endotoxin and physical faetors. By study of Chrysomyia megacephala larvae and pupae we found they contained indueible antibaeterial and lectin aetivities in their hemolymph. This immunity response was provoked by primary infeetion with Eseherichia eoli. The baeterieidal aetivity was measured by lethal rate and zones of growth inhibition in the agar plates against Staphylococcus aureus. The lethal rate of the larvae hemolymph diluted 100 times against S. aureus was 12%. The baeterieidal and lectin aetivities reaehed the highest level at 36hr and 48hr respeetively after injeetion. The leetin aetivity reached 512(titre) from 32 and 16 in the hemolymph of larvae and pupae respeetively. This level was maintained till 72hr. Eleetrophoresis showed that in the hemolymph of indueed larvae and pupae there were 6 bands more than the eontrol.

#91

THE BIOLOGICAL CONTROL OF FOREST PESTS IN XINJIANG. Wen-liang Ma (Xinjiang Academy of Forestry, Urumqi, 830063, China)

The paper summarizes the progress of the biological control of forest pests in Xinjiang, and the experiments and application of it. It consists of : 1. The preparation of Bacillus thuringiensis is effective to the pests of Lepidoptera. 2. Beauveria bassiana is invalid generally. 3. Stilpnotia salicis NPV and Apocheima cinerarius NPV are effective. 4. Trichogramma spp.has a little effect to Apocheima cinerarius, Stilpnotia salicis and Dendrolimus superans. 5. The natural effect of Telenomus spp is rather good, but to raise Telenomus spp is difficult. 6. Arma custos is effective to Stilpnotia salicis and Phalera bucephala. 7. The biological control of Quadraspidiotus perniciosus. 8. The influence of natural enemy to Dendrolimus superans. 9. The sex attractants of Apocheima cinerarius and Parathrene tabeniformis.

#92

CHARACTERS AND INSECTICIDAL POLYPEPTIDE OF BT, STRAIN AG

Ren Gaixin, Liu Xia, Xun Haishan, Wang Jian (Department of Biology, Nankai University, Tianjin 300071, China)

A new strain of Bacillus thuringiensis Ag (Bt.Ag) isolated from China, very toxic to Noctuidae larvae had been identified as belonging to B.t.H serotype 4a-4c according to the biochemical and serological tests. Bt. Ag have been investigated further for the antigram, esterase type, pattern of plasmids and the immunological homology among the crystalline proteins of Bacillus sphaericus (Bs.), Bt. var. israelensis (Bti.) and other Bt. strains. Except its pattern of plasmids, all of the other characters were same with the reference strain 023 (Bt. var. Kenyae). Crystals of Bt Ag were represented in four morphos under electromicroscope. The purified crystal extracts of Bt. Ag mainly contained a 61 KD toxic polypeptide immunologically related to the Lepidoptera-specific crystal protein from Bt. strains HD-1(H3a-3b), 1-7601(H4a-4b), 023(H4a-4c), and 7501(H4a-4c), but not related to the Diptera-specific crystal proteins from Bti (H14) and Bs. strain Ts-1 by ELISA.

#93

DISTRIBUTION AND INSECTICIDAL CHARACTER OF BACILLUS SPHAERICUS IN MUD-SOILS OF CHINA. Ren Gaixin, Fan Tianyu, Wang Xiuling, Jian Nan, Wang Jinfang, Yan lin, Zhang Yanhui, Zhang Hongyan (Dept. of biology, Nankai University, Tianjin 300071, China)

245 samples of various types of mud-soils were collected in 46 regions from 28 provinces of China where have not previously been treated with Bacillus sphaericus (Bs.). About 2000 and more isolates were examined. Bacteria of typical Bs. appearance were isolated from mud-soil samples. In this survey, 48 strains toxic to mosquito larvae were recovered. 15 strains caused significant° 3rd instar larval mortality of Culex pipiens pallens (Cpp.). These toxic strains belong to serotype H5a-5b according to the classication based on flagellar agglutination. Electromicroscopy of these Bs. indicate that all these highly toxic strains contain 2-3 crystal inclusions (bipyramidal, cuboidal, ladder-like and rectangle) between the two layers of exosporium. There are no crystal inclusions in the low-toxic and nontoxic strains. Toxicities of the 15 strains to Cpp. larvae were compared with the reference strains 1593 & 2362. Results showed that these new isolates were highly toxic to Cpp. larvae. The ITu/mg value of strain Bs-831 (No.7) was 1.97 times and 2.19 times 2362 and 1593, respectively.

#94

A STUDY ON THE CONTROLLING EFFECTS OF B.T., BACILLUS THURINGIENSIS, UPON THE PESTS OF CROPS. Jia-quan Wu (Huang-gong Region Plant Protection Station, Huangzhou 436100, China)

From 1984 to 1990, nine pests were been controlled with B.t., Bacillus thuringiensis, such as Tryporyza incertulas, Chilo suppressalis, Cnaphalocrocis medinalis, Pectinophora gossypiella, Pieris rapae, Plutella xylostella, Heliothis assulta, Euproctis pseudoconspersa and Phyllocnistis citrella. The results showed that B.t. 82612 had good controlling effects to the nine pests. Over 80% rate of death were been obtained if Bacillus thuringiensis was used correctly. The area of using B. t. had amounted to one million mu(times) in the whole prefecture from 1990 to 1991. B.t. was good for health of mankind and didnot pollute the environment.

#95

ISOLATION AND IDENTIFICATION OF BACILLUS THURINGIENSIS 29 STRAINS. Yan Jian-ping, Luo Shao-bin, Cai Chang-jian, Chen Zong-sheng, Liu E-ying, Zhang Yong-mei (Wuhan Institute of virology, A cademia Sinica, Wuhan 430071, China)

We were isolated 29 cultures of Bt from 498 soil samples of Yannan, Quizhou, Sichuan province. Serological identification showed that the H-antigen and H-antisera of Bt 3397, 3452, 3555 and 3370-1 cultures did not agglutinate against the H-antisera or antigen of all reference standard strains of Bt serotype H1 to H23, and was agglutinated by the homogeneous H-type only at a high antiserum dilution of 1 : 12800 to 25600. Biochemical experiment showed a some difference. Amony isolates of Bt, the culture 3370-1 was a non-flagellar strain, not motile, form long-chain of vegetative cells. The antigen or antisera of culture 3370-1 did not agglutinate against antisera of Bt subsp. wuhanesis (a non-flagellum strain). The parasporal body produced by the culture 3370-1 is large rhomboidal size 1.01 x 2.84 um. Laboratory tests showed that spore-crystal complex of the 3370-1 was atoxic to larvae of Ledipterous, Dipterous and Coleopterous. On the basis of these results, we propose the name of Bt subsp. dailiensis(strain 3370-1). Other 3 isolates need further work.

#96

A SEROLOGICAL STUDY ON CRYSTAL OF BACILLUS THURINGIENSIS. Luo Shaobin, Zhang Yi-bing, Yan Jian-ping, Wang Hui-jic (Wuhan Institute of Virology, Academia Sinica, Wuhan 430071, China)

Double immunodifusion assay was used to investigate the crystal serological reactions of 32 Bt strains which contain 29 new cultures from soil samples by our laboratory. Results of tests showed the same crystaltype able to produced by several different H-type subspecies strains, similar more than one crystal-type also produced by the same strain depends on the crystal antigens. For example, the isolate 3301 (H5ab) is "thu" crystal-type only, 379-5(H13) with two crystal-type of "thu" and "fin"; isolate Tm13-14, G40-6 containing three or four crystal antigen complex-type etc. We were examined insecticidal acticities of Bt isolates with spore-crystal complex containing one to three or four crystal-type Vs several insect larvae showed its different activity spectium. Our test data indicated that there is an interrelationship between insecticidal activity spectium of Bt strain and its crystal-type Each antigen determinants of crystal may possess distinct host rang. So the more antigenic determinants the contains, the wider host range it possesses.

#97

THE PATHOLOGICAL STUDIES OF LARVAE OF CULEX PIPIENS FATIGANS INFECTED WITH BACILLUS THURINGIENSIS VAR. ISRAELENSIS STRAIN187.

Wang Yaonan (Dept, Biology Central China Normal Univ. Wuhan,China).

A parasporal crystal formed Bacillus 187 was isolated from soil by our Labratory. This strain is named Bacillus thurIbgiensis var. israelensis 187 (Chinese strain). It is highly toxic to 3 species of larvae of the mosquitoes, Aedes albopictus, Culex pipiens fatigans, Anopheles sinensis.

After administering of strain 187 to the Culex pipiens fatigans larvae, the remarkable changes occurred in the anterior and posterior zones of midgut.In the former,the cell hypertrophy,high vacaulization of the cytoplasm, but the peritrophic membrane was still complete and the epithelum kept its monoglayer appearance. In the latter, it was more significantily damaged--cell lysis and sloughing, disintegration of the epithelied monoiayer,breakdown of the peritrophic membrane and spread of its content into the lumen.

The remarkable ultrastructural changes occurred in the mitochondria and endoplasmic reticula. The mitochondria were irregularly enlarged like vacuoles. Most of the rough endoplasmic reticula lost its ribosomes and the boundary lines of endopiasmic reticula were blurred.

#98

USE OF BACTERIAL SEED COATINGS FOR PROTECTION OF GRASS SEEDLINGS FROM GRASS GRUB ATTACK. T.J. Sadler, T.A. Jackson (MAF Technology, PO Box 24, Lincoln, New Zealand) and A.M. Moorhouse (Coated Seed Ltd, 2a O'Briens Rd, Christchurch, New Zealand)

The grass grub (*Costelytra zealandica* (White), Coleoptera; Scarabaeidae) is susceptible to infection by the bacterium *Serratia entomophila* which causes amber disease, accompanied by cessation of feeding, in the insect larvae. The bacterium is used in New Zealand as a biological control agent for protection of established pastures. To extend the use of the bacterium to seedling protection, trials were carried out with bacteria incorporated into a lime based seed coating of rye grass seedlings (*Lolium perenne*). Bacteria were incorporated into the seed coating at numbers ranging from 1 x 10^4 to 1 x 10^7 per seed and planted in 0.5 l volume pots each containing early third instar grass grub larvae in a series of insectary trials. Seed coating provided up to 80% seedling protection even with high numbers of grass grub. The degree of protection was related to the number of bacteria on the seed coat. Bacteria were isolated from the soil after sowing and significant levels of amber disease were found in the surviving larvae in pots with treated seeds. The technique is currently under assessment for protection of seedlings in the field.

#99

EFFECT OF TEMPERATURE, SOIL MOISTURE, pH AND MEDIA ON THE MYCELIAL GROWTH AND SURVIVAL OF ENTOMOPATHOGENIC FUNGUS BEAUVERIA BRONGNIARTII. Ho Yul Choo (Dept. of Agri. Biology, Gyeongsang Nat'l. Univ., Chinju, Gyeongnam, 660-701, Korea), H. K. Kaya (Dept. of Nematology, University of California, Davis, CA95616, U.S.A.), S. M. Lee(Southern Regional Branch Station, Forestry Reserch Institute, Chinju, Gyeongnam, 660-300, Korea).

The optimum temperature was 25°C for the mycelial growth of B. brongniartii (43.0±0.35mm in colony diameter) followed by 20°C, 27°C, 30°C and 15°C. 30% was the optimum soil moisture for the highest number of propagules (115.7±12.73x10^4cfu/g soil). As for pH, 5-7 was optimum for mycelial growth. Organic fertilizers made of sawdust or others were good media for the production of fungus. Pathogenicity of B. brongniartii was good to great wax moth in pot.

#100

Microbial Control of Rice Water Weevil with Two Entomogenous Fungi.

Eiji YOSHIZAWA, Kuniatsu KUWASAWA and Shigeyoshi KOHNUMA
(Nagano Agricultural Experiment Station, Suzaka, Nagano 382, Japan).

Rice water weevil (RWW), Lissorhoptrus oryzophilus , is an alien insect pest, and it was first found in Japan 1976. The overwintered adults fly into paddy fields immediately after the transplanting of rice seedling, and eat rice plant leaves, and the larvae dig into the soil and feed on the roots.

Three species of Entomogenous fungi, Beauveria bassiana, Metarhizium anisopliae and Hirsutella jonesii were isolated from the cadavers of RWW adults in Japan. B. bassiana and M. anisopliae were able to be mass-produced easily. Therefore, we have tried to control RWW with those fungi.

In order to infect the adults with floating conidia when the adults passed by the water surface of the treated paddy field, B. bassiana and M. anisopliae were cultured on the wheat bran medium and were propagated on the flooded rice paddy after the transplanting at the rate of 20 grams / m^2 for each fungus. The adults of RWW collected from the treated paddy field were highly infected with the treated fungi. The longevity of infectiousness of the propagated conidia to the adults of RWW were estimated to be 3 to 5 days for B. bassiana and 7 to 10 days for M. anisopliae.

The density of larvae and cocoons of the 1st generation of RWW was not reduced sufficiently, in the field experiments, especially at the moment of heavy outbreaks. As it took 3 to 9 days for the fungi to kill the adults, the infected adults were able to oviposit before their death as much as healthy ones, and it seemed to be the reason why the the insect population were not reduced sufficiently in the treated field.

#101

BIOLOGICAL CONTROL OF THE WHITE SPOTTED LONGICORN BEETLE, *ANOPLOPHORA MALASIACA*, BY THE ENTOMOGENOUS FUNGUS, *BEAUVERIA BRONGNIARTII*. I. Pathogenicity of *B. brongniartii* to the Adult Beetle.

Tomotoshi KASHIO (Department of Entomology, NIVOT, Kurume Brch., Mii-machi, Kurume, 830 Japan), Taka-fumi TSUTSUMI(Fukuoka Agric. Res. Ctr., Chikushino, Fukuoka 818, Japan) & Yutaka GYOUTOKU(Kumamoto Agric. Res. Ctr., Matsubase, Kumamoto 869-05, Japan)

The pathogenicity of *Beauveria brongniartii*, isolated from yellow-spotted longicorn beetle, *Psacotea hilaris*, towards the adult beetle of *Anoplophora malasiaca*, was assessed. The adult beetle was found susceptible to infection after spraying a conidia suspension of *B. brongniartii*. It died within 10 days at the conidia dose of 10^7/*ml* at 25°C. The difference of susceptibility between male and female was not recognized. LC_{50} of the conidia suspension was 9.5 x10^4/*ml*. High mortality was also recognized after the antennae and legs were smeared by the conidia suspension. *B. brongniartii* proves useful as a biologial control agent to the whitespotted longicorn beetle, based on these results.

#102

BIOLOGICAL CONTROL OF THE WHITE SPOTTED LONGICORN BEETLE, *ANOPLOPHORA MALASIACA*, BY THE ENTOMOGENOUS FUNGUS, *BEAUVERIA BRONGNIARTII*. II. Effect on the Different Application Methods of *B. brongniartii* on Control of the Adult Beetle.

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In a field cage test, the application of wheat bran containing *Beauveria brongniartii* conidia (10^7 - 10^8/g), previously cultured for about 2 weeks, to the ground around the trunk of citrus tree (20g/tree) was found to result in 95-100 % mortality within 10 days for the adult beetles. High mortality was recognized by suspending polyurethane foam and nonwaven fabric bands (0.5x5x50 cm) with conidia (10^7 - 10^8/cm^2) on the lower part of a tree, which have been exploited for the mass production of *B. brongniartii*. The conidia were maintained at high density (10^7</cm^2) with persisting for more than 1 month in the field. Conidia on wheat bran reduced to less than 10^7/cm^2 within 20 days. The suspension the of polyurethane foam and nonwaven fabric band are thus shown effective for *B. brongniartii*.

#103

BIOLOGICAL CONTROL OF THE WHITE SPOTTED LONGICORN BEETLE, *ANOPLOPHORA MALASIACA*, BY THE ENTOMOGENOUS FUNGUS, *BEAUVERIA BRONGNIARTII*. **III.** Field Applications of *B. brongniartii*

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Polyurethane foam and nonwaven fabric bands containing *Beauveria brongniartii* conidia (10^8/cm^2) were applied to several citrus orchards over a period of 2 years (1988-1990). Their suspensions from the lower branches of the trees resulted in high mortality (84-100%) of adult beetles of *Anoplophora malasiaca* at a dosage of 1 band per tree. High infectivity of conidia persisted for more than 4 weeks. Damage to the citrus trees by larvae could be controlled to low level because of the mortality rate. The suspension is thus shown effective for the biological control of *A. malasiaca*.

#104

PROPAGATION OF WANGDU HANPV AND STUDY OF CONTROLLING THE SECOND GENERATION OF BOLLWORM. Shi-ying Sun, Yu-hua Liu, Wei-gou Wang, Yu-yi Dai(Institute of Microbiolgy, Hebei Academy of Sciences, Baoding 071051, China)

Wangdu HaNPV was screened in 1983. The NPV was employed to infect the 8605 of healthy bollworms, incidence is 76.9%. A single bollworm containcd 1.315 x 10^{11}NPV.

230 Mu of cotton fields in Wuqiao and Dongguang counties were sprayed with the 6.0 x 10^{11}PIB, 6.0 x 10^{11}PIBwith 1.5 x10^4X K-OTHRIINE per Mu, and chemicals alone(control), bollworm decrease is 94.6--100%and 62--100% respectively 6 days after chemicals used. Damage of cotton bollworm is 0--0.22%, remainder of cotton bollworms per 100 cottons are 0--1.7, 0 and 0 respectively 9—12 days after chemicals used. 6.0 x 10^{11}PIB with 1.5 x 10^4X K-OTHRIINE per Mu was used in Wuqiao and Dongguang, bollworms decrease are both 100%, damage of cotton boll is 0—0.56% 9 days and 12 days after chemicals used.

#105

STUDY ON CONTROL PINE MOTH(DENDROLIMUS SPECTABILIS BUTLER) WITH PINE MOTH CPV. Yu-hua Liu, Guan-hui Huang(Institute of Microbiology, Hebei Academy of Sciences, Baoding 071051, China)

DsCPV was applied to control pine moth in Funing county, Hebei province in 1984 to 1986. Lc50 of DsCPV and dosage for 6th age of pine moth is 1 x $10^{5.7}$ PIB / ml and 2 to 4 x 10^{10} PIB / mu respectively. Larva reduction 6th to 7th age was above 70% 10 to 20 days after DsCPV used. DsCPV with addition of B. t(5x10^{10} spores / mu) increases death of larvae. The proportion of females decreases and 50% of adults pupated carried viruses with data of survivors collected in area tested. Virus can be transfered from one generation to next through eggs. Therefore it plays a role in control of next generation.

#106

MASS REARING OF SPODOPTERA LITURA AND IN VIVO MASS PRODUCTION OF ITS NUCLEAR POLYHEDROSIS VIRUS. Zhelong Pu, Qijin Chen, Qingxin Long, and Fusheng Liu (Institute of Entomology, Zhongshan University, Guangzhou, 510275, China)

The larvae of cotton leafworm, Spodoptera litura, have been reared successfully on artificial diet in which soybean flour and wheat bran were the principal ingredients for 20 and more continued generations at28-30°C and 70-80% R.H.. When the larvae developed into 4th-instar on the diet, they were collected and inoculated with polyhedra of SINPV which multiplied rapidly in larval tissues. The moribund larvae were grinded, centrifugalized and filtered. The SINPV preparation was preparaed in wettable formulation in which flour was used as the base and small quantity of synergist and spreader were added.

The bioassay for the SINPV preparation at a concentration of 2.5×10^8 PIB/ml against 3th-instar larvae at 30°C showed that the mortality was 82.64 per cent. Field trial using the preparation at the quantity of 75×10^8 PIB for one ha to control S. litura resulted in mortality around 90 per cent.

#107

A 15-YEAR STUDY ON THE NATURAL CONTROL OF MYIHIMNA SEPARATA [LEP: NOCTUIDAE] BY OVOMERMIS SINENSIS [NEMATODA:MERMTTHIDAE]. Guo Chen, Heng Jian, Huifang Ren (Biological Control Laboratory, CAAS, Beijing 100081, China)

The 1st generation armyworm, Mythimna separata, commonly occurs in Zhu Ma Dian Prefecturd, Henan Province in Central China. Field studies during 1975-1989 in Shangcai County and Xincai County of the prefecture confirmed that Ovomermis sinensis is an important parasitic natrual enemy of the armyworm. The average parasitization rate was over 40% with the highest reaching 90%, in 58% of the observation sites. Feeding capacity of the infected larvae reduced by 38% in average. In the laboratory of 18-20°C and 22-27°C, the infected larvae died 14 and 8 days, respectively, after infection. During an outbreak of the armyworm in 1984, when the larval population density was 30.3-119.5 larvae/m^2 in wheat fields of Dongan Village, Shangcai County, the natrual larval parasitization by the nematode was 35-45.5%. The defoliation of wheat was minimal with no pesticide application. Results of a data analysis for 1979-1985 revealed a signficant negative correlation between the natural parasitization of the pest in its first generation occurring area (e. g. Xincai County) and the number of trapped adults in is second generation occurring area (Jinzhou, Gongzhuling, Harbin of northeast China) . It indicated that suppression of the first generation armyworm population by conservation of the nematode may contribute to reduction of the initial population level of the migratory armyworm. In Zhu Ma Dian area, number of raining days, precipitation rate and relative humidity during late April to mid May were found to be the main factors influencing the fluctuation of armyworm parasitization.

#108

THE USE OF STEINERNEMA CARPOCAPSAE (EXHIBIT) FOR CONTROL OF ORNAMENTAL AND TURF INSECTS. L.A. LEMKE D. H. Houseworth (Ciba-Geigy Corp., P.O. Box 18300, Greensboro, N.C. 27419 USA).

In 1991, the Turf and Ornamental Group of Ciba-Geigy in the USA introduced the nematode Steinernema carpocapsae (tradenamed Exhibit) for control of ornamental insects and surface-feeders in turf. Exhibit has been shown to be effective against black vine weevil, fungus gnats and strawberry root weevils. Control varies depending on environmental conditions. When enough moisture is present and temperatures are not over 95 degrees control is as good as conventional insecticides. S. carpocapsae is effective against sod webworms, black cutworms and billbugs. However, this nematode is not effective against white grubs. This ineffectiveness is due in part due to their inability to penetrate the thatch.

#109

STUDY ON APPLICATION TECHNIQUES OF *STEINERNEMA GLASERI NC34* FOR THE CONTROL OF *AGRIOTIS YPSILON*. H. W. YANG, S. G. ZHANG, G. Y. ZHANG (Biological Control Laboratory, CAAS, Beijing 100081, China)

Screen of appropriate nematode species, searching of good application method, selection of attractive bait materials, and determination of optimum density of nematode baits in field were conducted from 1988-1991. *Steinernema glaseri NC34* had the highest infectivity to *Agriotis* larvae with LD50 of 64 infective juveniles. Under the dosage of 100 juvenile, the mortality of *Agriotis* larvae reached 80-100% by *NC34*, comparing with the mortalities of 76%, 20%, 43% by *S. Carpocapsae Agriotos, S. bibionis Otio, S. spp NC513*, respectively. The mortality of *Agriotis* reached 93% by the use of 10000 juveniles per larva mixed with nematode *NC34* bait in a pot. However, only 33% mortality was gotten by drenching nematode into potted soil with same dose. Soybean meal, wheat bran, rice bran, cotton seed meal as bait materials were tested. The soybean meal was proved to be the most attractive one to the larvae of *Agriotis*. The nematode bait was put in 6, 3, 2 baits per 3 square meters in a sweet pepper field and the damage reduction rate was 61%, 53%, 34%, respectively. On the contrast, that of control treatment of insecticide Phoxium was 56%. These indicated that *S. glaseri NC34* could be used as a bio-insecticide to control *Agriotis ypsilon*, but attention to the applied techniques should be paid.

#110

INTRODUCTION OF BIOSAFE (ENTOMOPATHOGENIC NEMATODE) IN THE JAPANESE MARKET. Satoshi Yamanaka, Masaji Kinoshita (Tsukuba Technology Center,SDS Biotech K.K. 300-26,Japan)

BioSafe® product (based on the entomopathogenic nematode Steinernema carpocapsae-Xenorhabdus nematophilus bacterium complex) is commercially available for the control of a number of soil-inhabiting insects of medium-high value crops in the United States, Canada, Denmark and Switzerland. BioSafe® is exampt from registration requirements in these contries including the U.S Environmental Protection Agency, largely because the nematode and its associated bacterium are naturally occuring organisms and their safety in the environment is proven. In Japan, studies on entomopathogenic nematodes started in 1980, mainly by universities under the sponsorship of the Ministry of Education. SDS Biotech K.K. research with BioSafe® started in 1988 through close collaboration with Biosys, Palo Alto, CA. The effort has led to optimize the practical usage of BioSafe against various turf insects (ie, japanese lawn cutworm, hunting billbug). SDS Biotech K.K. has filed for product registration, the first attempt to register a nematode-based product in Japan.

#111

ENTOMOPATHOGENIC NEMATODES FOR CONTROLLING SOME ECONOMIC INSECT PESTS IN THAILAND. Vacharee Somsook and Pimolporn Nanta (Biological Control Research Group, Entomology & Zoology Div. Dept. of Agriculture BKK. 10900 THAILAND).

In Thailand entomopathogenic nematode Steinernema carpocapsae Weiser, was studied for controlling insect pests in order to reduce the problem of using chemical insecticides. Field trials were conducted to determine the effectiveness of S. carpocapsae for controlling bark eating caterpillar, Cossus sp. and Microchlora sp., the major insect pest of Longkong trees (Aglaia domestica Pelleg.) and striped flea beetle, Phyllotreta sinuata the serious pest of chinese radish at Chanthaburi Longkong plantation and Bangkok vegetable growing area in 1986 and 1991 respectively.

The nematodes used in the field trials were mass produced in the laboratory by using dog food as artificial media. The cost of nematode production was about $ 0.2 per litre (2×10^6 nematodes/litre). The experiments showed that adequate control of the bark eating caterpillar up to 80 % was resulted from 1000-2000 nematodes/ml. and good control of striped flea beetle larvae was obtained by spraying 4×10^6 nematodes/ml/10 m^2

#112

#113

THE METHODS AND EFFECT OF UTILIZING ENTOMOPHAGOUS NEMATODE HETERORABDITIS SP. TAISHAN NO.1 FOR CONTROLLING PEANUT SCARABS. Suchun Li (Zhongkai Agrotechnical College, Guangzhou, 510255, China)

Holotricha parallela M. and H. oblita (F.) are major pests of peanut field in Jiangsu Province. In this paper the methods of utilizing nematode, Heterorahabditis sp. Taishan No.1 for controlling the peanut scarabs larvae (PSL) were described. It included: The various nematode concentrations, different treatment methods, various larvae stages and various soils. Results have been achieved from various test plots in the field. Survial of PSL in plots treated with nematode showed low population:0-2505/ha the peanut yield showed singificant increase:3750-4740kg/ha. The other plots with phoxim showed high population of PSL:82500/ha in average and the yield was 1875kg/ha only.

#114

RESEARCH ON THE TECHNIQUE OF MASS REARING ENTOMOGENNOUS NEMATODE, HETERORHABDITS SP. TAISHAN NO.1. Suchun Li, Jueyu Zhang, Jianping Chen (Zhongkai Agrotechnical College, Guangzhou 510255, China)

A method for mass rearing Heterorhabdits sp. Taishan No.1 was described. Medium mainly consisted of pork intestine homogenate put in 20000ml fermentation flask, each container was loaded with 3-3.5kg of medium, and aerated. 300000-615000 infective juveniles were produced per gram medium in 12 days. The technique is suitable for industrial production and laboratory use.

#115

RELATION OF ENTOMOPATHOGENIC NEMATODES WITH THE WHITE GRUBS IN NORTH OF CHINA. Jing-yue Cui, Bao-sheng Wang, Su Jun, Zhong-xiu Li, Qing-lei Wang, Chun-Qin Liu (Cangzhou Agriculture Institute, Cangzhou, Hebei 061001, China)

Researeh suggested that in clay loam, when the soil moisture content is 23.5% and the soil temperature is 28℃, nematode can move above 40cm in the direction of level after 48hs. The rate of migration is 0.96cm / h in the direction of verticality. When the soil moisture content is below 15%, migration is slowed up obviously. Nematode can spend and survive in winter in zone of north latitude 38 degree and percentage of survival of it is between 15.5%–20.3%. The pathogenicities of nematode(Steinernema glaseri) to three kinds of the white grubs in north of China are among 33.3–92.6%. The white grubs infested by nematodes in the soil can make ten healthy white grubs infected in region in radius of 11cm and form a new source of infection. Pot test showed that controlling the white grubs (Holotrichia parallela and H. oblita) by use S. glaseri(7.5–30 x 10^4 nematodes / m^2) in peanut field can reduce the population of two kinds of the white grubs to 81.75%.

#116

RESEARCH ON CONTROL OF GRASSHOPPER IN PRAIRIES BY RECRUITING STURNUS ROSEUS, Xinchun Zhao (The Control Station of Locust and Rodent Prediction and Control of Xinjiang Uygur Autonomous Region, Xinjiang 830001, China)

Sturnus roseus is a kind of summer resident bird eating locust in Xinjiang. The bird has a natural habit of living and making their nests in flocks amidst piles of rocks. From 1981 till now, the Sturnus roseus has been successfully recruited in some parts of grasshopper by piling up stones and making permanent nests on walls.

A great deal of Sturnus roseus are living and breeding in the man-made nests every year. The population of locusts in the areas of the Sturnus roseus recruitment have been completely controlled and no need for insecticide.

#117

EXPERIMENTAL STUDIES ON SANTONIN TO CONTROL CARPOSINA NIPPONENSIS. Tang Li, Yun-ning Zhou, Mei-li Lian, Xiao-xiu Zhang (Shanxi Plant Protection Institute, Taiyuan 030031, China).

During 1988-1989, the authors have made an experiment of controlling the peach fruit-borer (C. nipponensis) by 0.6% santonin, which is mainly composed of Artemisia maritima and Chinese medicinal herbs, has low toxicity, no residue and is safe to natural enemies. The result of bioassay in the lab. shows that the correct ovicidal rate for santonin 400 x, 500 x and 600 x are 100%, 97.7% and 97.7% separately. The correct insect killing rate for santonin 400 x, 500 x and 600 x are 100%, 88.6% and 87.3% separately. Results of the field trial show that the insect injuries rate of fruits are between 2.1-6.2% for santonin 400-600 x, while more than 40% in the CK. A good result is also obtained in demonsration fields.

#118

SEX BEHAVIOUS OF ADULT OF HOLOTRICHIA TRICHOPHORA(FAIRMAIRE) AND HORMONE USE TEST. Bao-sheng Wang, Zhong-xiu Li, Qing-lei Wang, Jing-yue Cui, Chun-qin Liu (Cangzhou Agriculture Institute, Cangzhou, Hebei 061001, China)

Study showed that adult(Holotricha trichophora Fairmaire) go out from the soil in shorter time. Female adult can only crawl short direction and go into the soil and egg in it, which has a behaviour of egging in deeper soil, and form a closed destroy region after long years. Sex induction ability of adult is very strong. Male adult can only coitus one time. Test showed sex hormone can be collected with ether in abdomen region of female adult and roughing extraction materials can be stored in 0–10℃ for two years and hold a strong activity. Releasing the roughing extraction materials to kill male adult, in natural condition, the larvae population can reduce 96.9%.

#119

EFFECT OF PHYTOHORMONES ON THE RESISTANCE OF ZEA MAYS TO OSCINELLA FRIT L. E. N. Kislin, T.V.Semichyeva (Laboratory of Entomolgy, All Union Institute for Plant Protection, St Petersburg, 189620, RUSSIA).

The effect of exogenous phytohormones on the resistance of Zea mays L. to Oscinella frit L. has been studied after the preliminary treatment of seeds with water solutions containing the plant growth development substances:indole-3-acetic acid (IAA), benzylaminopurine (6-BAP), gibberellic (GA), and abscisic acids (ABA) with 25 and 100 mg/L. Resistant and unresistant hybrids were utilized in experiments. It was found that IAA (100 mg/L), GA (25 mg/L), and ABA (25 mg/L) considerably decreased the number of insects which were being fed on adult plants, while 6-BAP (25, 100 mg/L), IAA (25 mg/L) and GA (100 mg/L) increased the degree of plant damage by insects. 6-BAP (100 mg/L) also inhibited the plant growth and increased the biological damage of plants. All the studied substances has been changed the growth and development both of plants and insects. It has been assumed that the resistance of Zea mays L. to Oscinella frit L. might be caused by the changes in the assimilate flow to the feeding points. The changes in the assimilate flow are controlled by the phytohormones.

#120

STUDIES ON CHEMOSTERILANT TH—6040 FOR ARMYWORM MOTH. Wen-chen Zhao, Hui-sheng Jiao, Jian-cheng Li(Plant Protection Institute, Hebei Academy of Agriculture and Forestry Sciences. Baoding 071000, China)

This new method to control the pests, armyworm moth, with the chemosterilant TH–6040 has been researched in laboratory since 1980. The insects was fed in Mitlin ways. The results showed that the sterility rate of moth eggs reached up to 99.6% when male and female adults within 1 day after their emergence were treated at concentrations of 5–50ppm, and sterility rates of 98.4% and 99.3% were produced when the adults were 3 days after emergence treated at the same concentrations. the effectiveness was quite remarkable and seemed to be independent obviously from days of moth emergence. The results have also the importance and value in practical use for controlling the migratory armyworm moth.

#121

STUDY OF IRRADIATION EFFECT AND MECHANISM OF RADIATION-INDUCED STERILITY WITH CHINESE CITRUS FLY DACUS CITRI. Yuan-ying Li, Wei Zhang (Institute for Application of Atomic Energy, Chinese Academy of Agricultural Sciences, P.O.Box 5109, Beijing, China)

The pupal development, morphology of the reproductive system and genesis of the germ cell of the Chinese Citrus Fly (CCF) were studied in the paper. Somatic cell developed and ended in the latest pupae while germarial cyst in female pupae and there were many mature sperms in the spermary in male ones. When pupae were exposed to 9Krad gamma-ray in the stage, the adult could be in induced full sterility. It suggested that the latest pupae is optimum irradiating period and the 9Krad is appropriate irradiating sterile dosage that does not damage significantly to flight ability and mating capacity of the adult. The study also showed the number of chromosomes of CCF were 2n=12. Total length of chromosome were 56.2um, and the deviation of chromosomal length was from 6.52 to 1.10 um. The Karyotype is not symmetric. The content of DNA in salivary gland and intestinal cell of larva of CCF declined in 24 hours after irradiation but recovered gradually.

#122

STUDIES ON THE STERILIZATION OF SOYBEAN POD BORER USING NUCLEAR RADIATION. Zhunling Du, Xiaoli Zhao, Yao Li (The Institute of Plant Protection, Academy of Agricultural Sciences of Heilongjiang Province, Harbin 150086, China)

In this paper, it was studied systematically to control soybean pod borer using the sterile technology of the nuclear radiation. 1. Artificial rearing: 1) By changing photoperiod, the diapause was broken and the highest percentage of emergence was got with 18 hours illumination per day. The duration of diapause was decreased from 10 months to about 1 month. So that, it took 40-42 days to reproduce one generation. 2) The suitable prescription of the artificial diet was selected. When the larvae were feed with soybean sprouts, the high servival rate of them was achieved and their development was normal. 2. the suitable treatment period and radiation dosage was cleared. The radiation treatment should be conducted during two days before adult emergence and the fitting radiation dosage should be 12, 000 R. Treated as above, the emerged adult was normal. The eggs laid were not able to hatch. 3. When putting the adults emerge from the treated pupae into screen in the soybean field, the control effect was 88.1-99%, the rate of seed-boring reduced from 10.1% to 0.1-1.3%. So it is a new method of using the sterillzed technique by nuclear radiation to control soybean pod borer.

#123

CONTROL OF CHINESE CITRUS FLY DACUS CITRI WITH RELEASING THEIR IRRADIATED STERILE MALES. Heqin Zhang, Huasong Wang (The institute for Application of Atomic Energy, Chinese Academy of Agricultural Sciences, Beijing 100094 , China)

This paper reported the study result concerning control of chinese citrus fly with irradiation sterile insect technique in field test in Guizhou Province, southwestern China. 9 krad of gamma-ray at about 100 rad/min and pupae two days before emergen were determined as appropriate sterile irradiation dose and irradiation stage.

The longest distance for recapturing the marked irradiated fly from the release site was 1500m. The wild chinese citrss fly marked with fluoresent powder also recaptured at 1500m. Both recaptured sites located in north from release places, and it showed that the dispersal direction was effected by wind. Irradiated sterile flies also habitated around citrus trees and bamboo trees nearby where there was breeze. The mating of irradiated sterile fly was synchronous with native fly in field.

About 56000and 95000 irradiated sterile chinese citrus fly males have been released respectively in May 13-June 20, 1987 and May 17-July 5, 1989 in a orange orchard covered 35 hectares (4800 orange trees) in Guizhou Province. The release ratio of sterile to native was 12.5:1 in 1987, 45:1 in 1989. The fruit damage rate dropped down to 0.16% from 7.5% in 1987, and to 0.005% from 0.20% in 1989. However, in the untreated orchard, as control, the damage was about 20%.

#124

THE FRASS-RING INDEX-- A NEWLY DEVELOPED CRITERIUM FOR LABORATROY EVALUATION OF MAIZE PLANT RESISTANCE TO CORN BORER. Yun-xia Gao, Da-rong Zhou, Li-ping Wen, Zhen-ying Wang, Yan-ying Song(Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Zhou et al.(1984) developed a bioassay technique by using lyophilized diet plugs absorbed with juice of testing whorl tissues of young maize seedling, the resistance can be evaluated by larval weight(LW) after feeding on the plugs for 5-7 days. However, the weighing process was too tedious to be adopted as a practical technique. In this paper, the frass-ring index(FRI), a newly developed criterium for resistance evaluation, was reported which can be used to replace the LWI successfully. Since the lyophilized diet plugs(LDP) absorbed with juice from susceptible maize materials resulted into larger larvae and produced more frass surrounging the plug at the end of incubation, which can be easily observed/measured after removing the plugs. The width(W) and completeness(C) of the ring was highly co-related to the susceptibility of the tested maize materials. So, the FRI(=WxC) can be used as a new criterium for laboratory resistance evaluation, which is far more labour-saving than the LWI. The FRI has been divided into 4 categories: < 0.4:Highly Resistant;0.41-0.5:Resistant:0.51-0.6:Intermediate Resistant; 0.61-0.7:Susceptible, and > 0.71:Highly Susceptible. This technique has been repeated for 594 times with 23 inbreds/hybrids of different resistance to the Asian corn borer Ostrinia furnacalis, and proved to be in significant or highly significant consistensies with results obtained with the field infestation technique.

#125

ROLE OF HYDROXAMIC ACIDS IN THE RESISTANCE OF MAIZE TO WESTERN CORN ROOTWORM, *DIABROTICA VIRGIFERA VIRGIFERA* LECONTE. Yongshou Xie, J. Thor Arnason and Bernard J.R. Philogène (Department of Biology, University of Ottawa, Ottawa, Canada K1N 6N5)

The role of the maize secondary metabolites, hydroxamic acids, in the interactions of maize and western corn rootworm was investigated under greenhouse and laboratory conditions.

An accurate high-performance liquid chromatography (HPLC) method was developed for the separation and quantification of hydroxamic acids in maize root extracts. This approach represents the first gradient HPLC method to separate a variety of hydroxamic acids and derivatives in maize root extracts. The highest concentration of hydroxamic acids was found in 4-week-old maize root extracts, which overlapped with the time of development of western corn rootworm larvae. Hydroxamic acids are concentrated in the cortex of maize roots, which is the feeding site of western corn rootworm larvae. The high concentrations of these substances in the cortex of maize root may be relevant to the resistance of maize varieties to subterranean pest insects.

Under both greenhouse and laboratory conditions, different maize lines with various hydroxamic acids content were evaluated for resistance to western corn rootworm larvae. Maize lines with high hydroxamic acids stressed western corn rootworm larvae to produce inferior adults, and showed significantly less damage than those with low hydroxamic acids. The larval development parameters measured were significantly correlated to the hydroxamic acids levels in maize roots. The behavioral responses of western corn rootworm larvae to naturally occurring and synthetic hydroxamic acids were investigated. The results clearly indicated the behaviour-modifying effect of these substances.

This is the first evidence showing that phytochemical factors, such as hydroxamic acids, are involved in the resistance of maize to western corn rootworm.

#126

EXTRINSIC RESISTANCE OF SORGHUM GENOTYPES TO *Contarinia sorghicola* (COQ., 1898). Campos, A.R. (FEIS-UNESP, 15378 - Ilha Solteira, SP, Brazil), E. Berti-Filho (ESALQ/USP, Piracicaba, SP, Brazil), F.M. Lara (FCAV-UNESP/CNPq, 14870 - Jaboticabal, SP, Brazil), I.M.P. Rinaldi (IBBMA-UNESP, 18600 - Botucatu, SP, Brazil), R. Batista (MZ/USP, 01000 - São Paulo, SP, Brazil).

The influence of sorghum genotypes on some natural enemies of *C. sorghicola* (extrinsic resistance or defense) was investigated in field conditions. The experiments were set in Ilha Solteira, SP: two in the dry season (evaluated in May/June/1988 and May/1989) and one in the rainy season (evaluated in February/1989). The genotypes tested were: AF-28, IAC-83/75-5-1-6, TX-2536, BR-300, IPA-201 and Sart. For the evaluations, 40 panicles were covered with bags and collected per day/genotype, during 14 days from the beginning of the blooming period. The results were as follows: the highest population levels of the two main predators of the sorghum midge, *Orius* sp. (Heteroptera) and *Doru lineare* Eschs. (Dermaptera) occurred from the 2nd to the 4th day after the beginning of the blooming stage; the number of natural enemies collected from plants sowed in the dry season was higher than that collected from plants sowed in the rainy season; the spiders presented the highest number of natural enemies collected, and the species *Alpaida vanillae* (Keys.), *Chyracanthium subflavum* (Blackwall) and *Misumenops pallidus* (Keys.) were the most abundant ones; IPA-201 was the most attractive genotype to *Orius* sp. and *D. lineare* while IAC-83/75-5-1-6 was moderately attractive to *D. lineare*.

#127
INTERACTION BETWEEN STYLET PENETRATION OF GRAIN APHID AND HYDROXAMIC ACID CONTENT IN WHEAT SEEDLINGS. Bogumil Leszczynski (Department of Biochemistry, Agricultural and Pedagogic University, ul. Prusa 12, 08110, Siedlce, Poland), W.F. Tjallingii (Department of Entomology, Agricultural University, 6700 Wageningen, The Netherlands), A.F.G. Dixon (School of Biological Sciences, University of East Anglia, Norwich NR47TJ, United Kingdom)

Electrical penetration graph (EPG) is an useful technique for studying a mechanism of the host-plant resistance to aphids. Here the EPG patterns are compared with concentration of hydroxamic acids (resistance factor) in moderately resistant and susceptible wheat seedlings. EPG recordings over 4h showed that studied resistant cultivars reduced phloem ingestion (E2 pattern) and stylets movement through epidermis and mesophyll tissues (ABC patterns). Moreover an increase in nonpenetration and undefined pattern E1 was observed too. A high negative correlation between E2 and ABC patterns and content of DIMBOA (main wheat hydroxamic acid) as well as DIMBOA-glucoside in the studied wheat seedlings was found. There was also oberved a high positive correlation between percent of E1 pattern and DIMBOA concentration in the wheats. The grain aphid feeding behaviour on resistant and susceptible wheat cultivars is discussed.

#128
BIOLOGY OF ZYGOGRAMMA SUTURALIS [COL. :CHRYSOMELIDAE], AN INTRODUCED BIO-CONTROL AGENT OF AMBROSIA ARTEMISIIFOLIA. Fang-hao Wan, Ren Wang (Biological Control Laboratory, CAAS, Beijing, 100081, China)

Zygogramma suturalis was introduced from Canada and USSR to Beijing in 1987 against Ambrosia artemisiifolia. The results of biological studies showed that the average longevity of the female and male adults was 82.5 and 67.8 days, respectively, under a constant temperature of 26±1℃ . The mated females began oviposition 16.5 days after their emergence from the soil. Oviposition lasted an average of 49. 1 days with 394.5 eggs laid per female. Threshold temperatures for development of eggs, larvae and pupae were 10.5, 11.1 and 6.9℃, and the effective accumulative temperatures for eggs, larvae and pupae were 62. 9, 178.9 and 219 day-degrees, respectively. The egg hatching rate was 76.7%, 80% and 86%, respectively under constant temperatures of 28℃ , 32℃ and the room temperature (20-27℃). Under the rearing temperatute of 16-28℃ , larval and pupal survival rate varied between 61. 5-75% . Survival of the lst instar larvae was affected by low temperature, while high temperature influenced the survival rate of the 3rd and 4th instar. Humidity showed no significant effect on the larval survival.

#129
THE USE OF MIKROBIOLOGICAL AGENTS TO CONTROL PESTS ON THE VEGETABLE CROPS IN THE UKRAINE. N.V.Lappa, V.M.Goral, Ukrainian Jnstitute of Plant Protection Kiev, Ukraine.

The systems of the vegetable crops biological protection in the open and underglass soil are worked out,that allow to obtain hygienically pure products without the use of chemicals or with their minimal application.In the greenhouses the fungae products are preferably used: Boverin,Matarrisin,Aschersonia,Verticillin in the combination or in turns with Encarsia formosa and Phytoseiulus persimilis.With their helf the populations of Trialeurodes vaporariorum, thrips and spider mites are regulated.The technology is worked out to obtain biological products on the big microbiological enterprises and in the numerous biolaboratories.In the open soil the bacterial products are used in general based on bacteria from the thuringiensis group to control Lepidoptera and the fungae products-Boverin and Metarizin-to control the Coleoptera larvae.The pathogenous agents of dissases are oppressed,by the antagonists of fungae nature. The product is proposed on the basis of nonsporenforming bacteria,possesing complex properties to control pests and diseases.

#130
APPLICATION OF ANALYSIS FOR DIGESTIVE ENZYMES ACTIVITY FOR INVESTIGATION OF FEEDING SPECIALIZATION OF PREDATOR *CHRYSOPERLA CARNEA* STEPH. Muntyan E. M., Sekirov I.A., Yazlovetsky I.G. (All-Union Institute of Biological Methods in Plant Protection, Kishinev, Moldova, U.S.S.R).

The activity of some digestive enzymes(acid RNase ,amylase, trehalase and invertase) and their enzyme forms in polyacrylamide gel (PAAG) were tested on insects, reared in laboratory on different food(two species of aphids, larvae of *Galleria mellonella*, different artificial diets, eggs of *Sitotroga cerealella* and *Barathra brassicae* L.)

The feeding substrate was affected total activity of enzymes and their zones of activity in PAAG. The data obtained confirmed that some acid RNases and trehalase found in the midgut of predator derived form analogous enzymes of the prey. Thus the analysis of activity of these enzymes can be used in investigation and determination of trophical connections of the predator.

#131
ATTEMPTS TO REAR *IN VITRO* THE ECTOPARASITE *ELASMUS ALBIPENNIS* THOMPSON (CHALCIDOIDEEA:ELASMIDAE). Yazlovetsky I.G., Nepomnyashaya, A.M., Ageewa L.I. (All-Union Institute of Biological Methods in Plant Protection, 277070, Kishinev, U.S.S.R.)

The ectoparaasite *Elasmus albipennis* Th. has been studies in the U.S.S.R. as a promising agent for biocontrol of orchard leafrollers (Kowlenkov et al., 1991). We began studies on the development of the artificial food substrates for its larvae as the base for alternative mass rearing technologies. We managed to prove principal possibility for its *in vitro* rearing using the technique earlier described for another ectoparasite *Bracon greeni* Ashmead(Xie et al.,1989).The yield of adults constituted not less than 50% when larvae of *E. albipennis* were bred starting from the 2nd instar. The nutritional diet consisted of the hemolymph of *Barathra brassicae* L. pupae(80%), chicken yolk (10%) and dry milk (10%). Larvae of *E. albipennis* freely fed through the Parafilm "M". Attempts to breed them on the artificial nutritional diet without insect hemolymph(which was successfully used for larvae of the ectoparasitoid *Bracon hebetor* Say (Yazlovetsky, Nepomnyashaya, 1989) failed. We began to develop a nutritional diet which could take into account nutritional requirements of *E. albipennis*.

#132
A COMPARATIVE STUDY OF THE DIGESTION PECULIARITIES OF PREDACEOUS BUGS *PODISUS MACULIVENTRIS* SAY AND *PERILLUS BIOCULATUS* FABR. AIMED TO DEEVELOP ARTIFICIAL NUTRITIONAL DIETS. Sumenkova V.V., Yazlovetsky, I.G. (All-Union Institute of Biological Methods in Plant Protection,Kishinev 277060 Moldova, U.S.S.R.)

In recent years several recipes of artificial nutritional diets have been described for rearing of *P. maculiventris*, a promising entomophage of the Colorado potato beetle, *Leptinotarsa decemlineata* Say (Khlistovsky et al. 1985; Adidharma, 1986) We have tested nutritional diet consisting of the hemolymph from lepidopterous pupae (15%), chicken yolk (25) and dry milk(2%). In this case the yield of *P. maculiventris* adults constitutes up to 70%. However, our attempts to breed *in vitro P. boculatus* haven't been successful. In order to clear out possible reasons of such failures, a comparative study have been done on digestion peculiarities of these predators. It has been revealed that the activity of salivar glands proteases in larvae and adults of *P. bioculatus* was 30 times lower than in *P. maculiventris*. Besides, *P. bioculatus* considerably yields to *P. maculiventris* in midgut protease spectre. It explains greater demands of *P. bioculatus* to the composition of nutritional diets.

#133

THE USE OF LADY BEETLES IN BIOLOGICAL CONTROL OF PLANT PESTS IN USSR. V.N.Kuznetsov (Institute of Biology and Pedology, Far East Branch, Academy of Sciences USSR, Vladivostok, 690022, USSR.

Coccinellidae are widely used in biologocal control against the plant pests. At present the application of lady beetles is conducted in the following directions: introduction and acclimatization, collection of beetles in hibernation places of mass gathering, seasonal colonization, use of lady beetles in the greenhouse, conservation of local species of lady beetles and increase in their effect. More than 20 species of Coccinellidae were introduced into a zone of Soviet subtropics from abroad but the following species were acclimatized: Rodolia cardinalis Muls., Chilocorus bijugus Sh., Serangium parcesetosum Sicard.

#134

EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY ON STORAGE OF TRICHOGRAMMA OSTRINIAE PANG ET CHEN. Hongyin Chen (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

Trichogramma ostriniae which have diapaused still maintain very high vigor after 6 months' storage under four different low temperature environments of 3-5℃, 8℃, 0℃ for ten days then changed to -5℃, and 0℃ for twenty days transferred to -10℃. The average eclosion rate could reach 73.27%, with an average oviposition rate of 43.5 eggs by each individual female, and an adult longevity of 3.9 days. Under the relative humidity of 38%, 50%, 71%, 92% and the temperature of 3-5℃ the emergence rate of the wasp could reach 7.0%, 16.4% 66.6% and 78.6% respectively.

THE APPLICATION OF ENZYNE IMMUNOSOTBENT ASSAY (ELISA) FOR IDENTIFYING THE PREDATORS OF ORIENTAL ARMYWORM MYTHIMNA SEPARATA (WALKER) Kui Huang, Yuyuan Guo, Yunlu Xie,(Institute of Plant Protection, CAAS, Beijing 100094, China)

An enzyme-linked immunosorbent assay (ELISA) was used to examine the gut contents of potential predators collected from the wheat field in Henan and Jiangsu, China, in order to detect the predation of natural enemies on the small larva of oriental armyworm Mythimna separata (Walker) . The assay was confirmed to be specific and sensitive with the minimum detectable amount of 0. 1mg (worm weight) /ml, and the antiserum by absorption was not shown to react with cereal aphids as well as predators not exposed to the prey. The maximum detection period of armyworm larva protein (antigen) in Pardosa T-insignita(Boes. et. Str.) wa 9. 5hr for 1 larva/spider and 23.5hr for 3 larva/spider. The assay indicated that the main predators were ladybird (Coccinella septempuneta L.) and some species of spiders . These results were compared with laboratory observations on predation.

STUDIES ON APPLYING B.T. TO CONTROL CORN BORER, OSTRINIA FURNACALIS, IN CHINA. Huang Lin(General Station of Plant Protection, Ministry of Agriculture, Beijing 100026, China)

The project controlling corn borer with B.t. was initiated in 1985. The best way was selected by comparing with different dosages and spray methods of B.t.. The control efficiency reached 80% by mixing 2.2-3kg B. t. /ha with 112.5kg sand. The aero spray with 2.25kg B.t./ha resulted in the same effect of the control. It can retrieve 2,600-3,000 working days spraying 500 ha per day. It was extended to 200,000 ha. of corn fields which were 30% of the total area under B.t. application, and restrained of 50,180, 000 kg loss of corn yield as well as increased of ¥ 17.060,000.

TEMPORAL DIVERSITY OF LARVAL PARASITOIDS ATTACKING RICE LEAFFOLDERS (RLF) (LEPIDOPTERA:PYRALIDAE). Yu-jie Guo and K. L. Heong (Entomology Division, International Rice Research Institute, P. O. Box 933, Manila, Philippines)

Field population of RLF in the Philippines composed of a complex of three species, Cnapholocrocis medinalis, Marasmia patnalis, and M. exigua. Experiments conducted in two locations during the wet season of 1989 recorded total of 15 (Laguna) and 12 species (N. Ecija) of parasitoids, which attack the egg-larval, larval, and larval-pupal stages of the RLF. They are either ecto- or endo-parasitoids, and either mono- or poly-phagous. Such a larger variety of the species provides wide opportunities for parasitoids to reduce the RLF population. The species attacking early stages trended to have a high reproductive capacity with a smaller body size, those attacking old larvae shown a broader host range and usually have a short pre-mature period. Most of larvae were parasitized at 2nd or 3rd instar and killed before 5th instar. The dominant species and percentage of parasitism varied with plants stages as well as host larva density.

Diversity analysis based on the Hill's numbers indicated that only 2-3 of parasitoids were rated to very abundant species (N_2) over plant growing stages and the data fitted well with geometric of log series. The richness (N_0) and diversity (N_1) were nearly constant around 3-4. The evenness (E_5) was negatively correlated with host larval density. Larval parasitization of RLF can be considered as a key factor in suppressing and stabilizing the RLF field population.

LABORATORY EXPERIMENT ON CONTROL OF COLORADO POTATO BEETLE, LEPTINOTARSA DECEMLINEATA,WITH M-ONE AND TRIDENT. Yong-fan Piao (General Station of Plant Protection, Ministry of Agriculture, Beijing 100026,China), Mark Sears(Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1)

In laboratory experiments, effects of both formulations of M-One(Bacillus thuringiensis var. san diego) and Trident(Bacillus thuringiensis var. tenebrionis) on plant consumption, mortality and weight change of Colorado potato beetles (CPB), Leptinotarsa decemlineata were observed. Concentrations ranging from 0.5-20% of M-One and Trident formulations resulted in 50-97% mortality of second and third instar at 97h after initial exposure. Feeding inhibition of third instar was induced after ingestion for 24h and inhibition continued on untreated plants for at least 96h in most concentrations. Second instar and some third instar were able to resume feeding after the initial 24h exposure to lower concentrations of both products. Weight change of the beetle larvae was directly related to consumption of treated plants.

COVERCROPPING AND INSECT PEST MANAGEMENT IN APPLE ORCHARD. Deqiao Chen (Information Centre, Chinese Academy of Agricultural Sciences, Beijing 100081, China)

Experiments were conducted during 1986-1988 to evaluate the effect of covercropping of bird rapae and alfalfa between the rows of apple trees on the populations of insect pests and their natural enemies on apple trees and cover crops. Results indicated that the numbers of Chrysopa sinica Tjeder, Orius minutus L. and other predators on trees which were covercropped were much more than those with no undergrowth, and the population of C. sinica on trees with bird rapae covered was higher than that with alfalfa covered in early season (before June 20), and lower later. The population of the key pest Tetranychus viennensis Zacher on trees was different among the three treatments i.e. 1.37, 2.45 and 4. 01 active stages per leaf on June 20 with bird rapae covered, alfalfa covered and no undergrowth respectively, and the ratio of predators to mites was 1:30, 1:78 and 1:259 respectively. In the whole season, only one spray of mitecide Omite was applied (on June 21). The numbers of Aphis citrecola Van der Goot and other insect pests were also lower on apple trees with cover crops than those with no undergrowth. Therefore covercropping should be considered as one of the effective strategies of Integrated Pest Management in apple orchards.

ACTIVITY OF B. T. AGAINST PEANUT GRUB (HOLOTRICHIA OBLITA AND H. MOROSA) AND CHINESE CHIVE MAGGOT (SCIARA SP.) Juncai Zang (Beijing Municipal Station of Plant Protection, Beijing 100029, China)

In the field pilot experiments, three methods such as seed dressing, root drenching and a mixture of the both with Bacillus thringiensis var. Krustaki were used to evaluate the activity of B. t. K. against peanut grub (H. oblita and H. morosa). The control effect of seed dressing with the B. t. (7.5Kg/ha) was 10%-37%, root drenching with the B. t. (1:500-800) at the beginning of grub hatch reached 16.6%-58.8%, mixing both methods was 48.9-59.1%.

In addition, pervasion of B.t.K.(1:300) to the root of Chinese chive (Allium odorum) leaded to 87.7% in 3 days and 94.6% in 10 days. Meanwhile, an increase in the yield was 35.5%.

SOME IMPROVEMENTS OF TRICHOGRAMMA RELEASE IN CORN FIELD AGAINST ASIAN CORN BORER. Gui-rong Shi (Miyun Station of Plant Protection, Miyun County, Beijing 101500 , China)

A wasp release box was specially made for keeping away from the attack of natural enemies and birds in trichogramma release against Asian corn borer Ostrinia furnacalis (Guenée). In comparison with the traditional release method, the rélease amount, number of sites and times of Trichogramma dendrolimi Matsumura per hactare were 150,000 vs. 450,000, 15 vs. 150-225 and 2 vs. 3, respectively, all have been significantly reduced, while the parasitization of host eggs and the decrease rate of host population, e.g. 88.3 and 97.3% respectively in 1987, were similar.

PARASITE-INDUCED ENHANCEMENT OF HEMOLYMPH ECDYSTEROID LEVEL IN HOST LARVAE. Zhi-fu Chen, Rong-jing Jiang, De-cheng Ding and Jian-hong Jiang (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China)

Ostrinia funacalis parasitized by Macrocentrus linearis prolonged fifth-instar larval development and stopped metamorphosis until parasite emergence. Parasitized larvae weighed more in fifth instar than unparasitized controls. In fifth stadium, ecdysteroid titer showed a peak on day 7 prior to pupation in unparasitized larvae, while it remained low in parasitized at the same time. A significantly high ecdysteroid titer appeared in day 13 host larvae, in which the prothoracic glands were irregular in shape and partially degenerated. HPLC-RIA analysis of ecdysteroids from 13-day-old host larvae demonstrated that ecdysone and mainly 20-hydroxyecdysone were present in hemolymph. Parasites dissected from 12-day-old hosts were cultured in vitro after washing with medium. A significant amount of ecdysteroid immunoreactive materials were detected in medium and the releasing rate of these materials in vitro remained constant for at least 24 h. This suggests that parasites may themselves secrete ecdysteroids into the host. The physiological role of the ecdysteroids released by parasite remains to be further investigated.

THE EFFECT OF FOOD DREGS IN PUPA TISSUE OF ANTHERAREA PERNYI ON THE DEVELOPMENT OF TRICHOGRAMMA AND THE TREATMENT OF THE PUPA TISSUE. Liansheng Zhong (Inst. of Plant Protection, Hubei Academy of Agricultural sciences, Wuhan 430064, China), Julan Zhang (Dept. of Bilolgy, Wuhan University, Wuhan, 430072, China)

The pupa tissue of Antherarea pernyi in artifical diets is indispensible to the development of Trichogramma. Containing 1.14% food dregs in the tissue is benefit for pupation and emergence of the parasite. For example, the diet made using the tissue containing 1. 14 food dregs could get pupation rate (%) and emergence ratio (parasite per egg) by 70.9 and 15.5 respectively, and 64.14 for the diet without the food dregs. One pupa contain usually 2.9% food dregs, so it will be enough to remove over 60% of the food dregs in the tissue of Antherarea pernyi, if the tissue is used as the ingrident of the diet. An experiment had indicated that smashing the pupa with a smash machine at 800 revolutions per minute for 5 minutes and filtering them through two layers gauze could remove 65% of the dregs that the amount we need.

A PRELIMINARY REPORT ON *LISONOTA* SP. LIVING IN *KAKIVORIA FLAVOFASCIATA*. Lei Hua, Yi-zhi Sun, Wen-tao Feng (Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

Ichneumon-flies, *Lisonota* sp., which live in larvae of the persimmon fruit worm, *Kakivoria flavofasciata* Nagano, with 70% parasitic rate, are with great control effects on population of the persimmon fruit worms. These wasps take place 2 generations in a year and live through the winter with the young larvae inside the hosts' bodies. The pre-pupa stage and the pupa stage is 10 and 15 days in 22.5℃ constant temperature, respectively. The period of adult emergence of the overwintering generation in both wasps and hosts is the same. The emergence peak time and the activity peak time is at 8:00-11:00 and 13:00-14:00, respectively. Female wasps begin to oviposit from the 2nd day of emergence. The adults' lifes are 5-20days, average 13.3 days in the overwintering generation and average 3.3 days in the first generation. But if being fed with the sugar-liquid, the adults can live 14-15 days in the first generation.

PERIODIC RESPONSES OF PARASITIC WASP *TRICHOGRAMMA EVANESCENS* WESTWOOD (HYMENOPTERA, TRICHOGRAMMATIDAE) TO LIGHT AND GRAVITY. A.S. DAHIYA, W.B. TSHERNYSHEV, V.M. AFONINA (FACULTY OF BIOLOGY, DEPARTMENT OF ENTOMOLOGY, MOSCOW STATE UNIVERSITY, MOSCOW-119899, USSR)

Phototropic and geotropic responses of *Trichogramma* males and females have been observed individually and in groups in a glass tube from morning till evening and it is found that males are more phototropic than females while females are more negatively geotropic than males. In females attraction to light decreases during mid-day while in males it is constant throughout the day. The negative geotropism in males increases consequently during the day while in females it is independent of the different time of the day. Change in phototropic reactions per hour is more in females than males and this frequency is more from 8 A.M. to 6 P.M. in females while from 8 A.M. to 1 P.M. in males. The frequencies of change in geotropic reactions are same throughout the day in both sexes. Under stress conditions, the normal behaviour of *Trichogramma* population is distorted so that to increase the number of positive phototropic females and negative geotropic males. Females which moved away more frequently from light produce 15% more females in their progeny than those which always attracted to light.

USING NATURAL ENEMIES TO CONTROL CITRUS PEST IN CHINA. Tongyuan Du, Weiguang Liang, Ming Li, Yuanding Lu (Guangdong Entomological Institute, Guangzhou, 510260, China)

Field investigations showed that predotory mite, Amblyseius newsami and Amblyseius nicholsi and others, predatory thrips, Aleurodothrips fasciapennis ,parasitoids, Encarcia citrina and Aphytis lingnanensis are important natural enemies for controlling citrus red mite and scales in south China. Mass rearing of A. newsami, A. nicholsi and A. fasciapennis, E. citrina, A. lingnanensis is very successful in laboratory. When the protective methods of predatory mite--a kind of weed Ageratum convzoides and other short root weeds are reserved in citrus orchards to improve ecological environment of orchards, and using selective pesticides are conducted, predatory mite and other natural enemies could be augmented in nature rapidly. The citrus orchards of releasing and protecting predatory mite were near 100 thousand of ha in south China.

PRELIMINARY SURVEYING INSECT ENEMIES OF CORN BORER. Guangan Yang (Plant Protection Station, Dongliao County, Jilin 136600, China)

The catalogue of insect enemies of corn borer were compiled after preliminary surveying from 1979 to 1985. Many species were described in detail, including 11 families, 46 species in Hymenoptera; 3 families, 8 species in Coleoptera; 1, 8 in Diptera; 5,6, in Hemiptera; 1, 5 in Nuroptera; 1,1 in Demaptera, among which there are many dominate enemies, such as Trichogramma, Macrocentrus linearis, Labidura japonica and so on. The protection and exploitation of these enemies are discussed.

STUDIES ON APPLICATION OF FIREWORKS WITH BEAUVERIA POWDER. Baoqi Cui (Forestry Office of Ganjingzi District, Dalian 116033, China)

Beauveria is widely used in the course of prevention and control of Dendrolimus spp. But it calls strictly for temperature and moisture. In order to achieve good results, it is essential to throw in the Beauveria powder at the proper time. Because it is difficult for artificial apparatus to throw in the poison in a large area, we developed the way for many people to throw in the poison together. In this way, the difficulty could be well overcome. We call it firework with Beauveria powder. When the firework explodes, the spores are spreaded into the space because of the shock. Meanwhile, it can improve the death rate of Dendrolimus spp. save the poison and lower the costs. The effect is very good.

THE INVESTIGATION REPORT ABOUT NATURAL ENEMIES OF RICE PESTS. Naiwen Teng (Plant Protection Station, Shenyang 110034, China)

Through investigation in field and experimental feeding indoor, the anthor found 39 species of natural enemies of rice pest, which included 12 species of parasitic insects, 9 species of preying insects, 10 species of spiders, 5 species of frogs, 1 species of nematode and 2 species of fungi. The growth and decline of Apanteles ruficrus (Haliday) which is the parasitic natural enemy of Naranga aenescens Moore was recorded. This essay provide scientific basis for protectiog and making use of natural enemies of rice pest.

STUDIES ON EFFECT OF USING TRICHOGRAMMA TO CONTROL OSTRINIA FURNACALIS GUENEE. Tiehan Li (Plant Protection Station of Xiuyan Manzu Autonomic County, Liaoning 118400, China)

The first generation of Ostrinia furnacalis can be effectively controlled by using Trichogramma dendrolimi Matsumura, parasitic percentage of eggs is 60-80%. The eggs of first generation of O. furnacalis begin on June 19-25, peak period are on June 22-July 10, end on July 10-31. Three factors which affect Trichogramma application in fields are release time, amounts, and weather. The release time is the key factor. The first time of Trichogramma releases which we call keytime and must adapt to early eggs. If we do so, Trichogramma not only control early eggs, but also do chain reaction. The amounts of Trichogramma releases are 159,000-225,000 per hectare.

THE STUDY OF CONTROLLING OSTRINIA FURNACALIS (GUENEE) WITH BACILLUS THURIGIENSIS BERLINER SPRAYED BY PLANE. Zhixian Liu, (Plant Protection Station, Shenyang 110034, China)

B. Thurigiensis can be used to control many kinds of pests in different plants, and it is very safe and effective. Shenyang has begun the experiments that used it by plane to control O. furnacalis since 1985.The result is satisfactory. The controlling effectiveness is about 70 percent ot the first generation of O. furnacalis. The area applying this method in Shenyang have accumulated to 145,666 hacters. A plane can spray 533666 hacters a day. The same area will need 1600-2000 men working a day. Because the B. thurigiensis is safty, has no poison to natural enemy and people, don't pollute environment, save money and be easy to use. Applying it by plane is a good technique to substitute for manual spraying to control O. furnacalis.

USING NATURAL ENEMIES TO CONTROL AGRICULTURAL INSECT PESTS. Liankui Feng (Plant Protection Station of Fushun City, Liaoning 113000, China)

Agricultural environment is spoilt by abusing pesticide, so people should use natural enemies which are very abandent in nature. The first ten days of June in Fushun, the ratio of natural enemies and aphids is 1: 110. 5, the middle ten days, natural enemies density suddenly increased and completely controled the pests such as Nilaparata lugens Stal and Nephotettix cincticeps Uhler. Parasitic percentage is 48.1%, general 20-30%, using pesticide rationally enable natural enemies to play a bigger role.

STUDIES ON USING BT869 CONTROLLING FALL WEBWORM HYPLANTRIA CUNEA (DRURY). Quan-zeng Tang, Hony-sheng Pan, Hui-lin Zhao, Kai Qi, Weiqing Yie (Forest Protection Station of Zongsan District, Dalian 116000, China)

By seperation and screening the Bacillus thuringiensis Kurstaki for many years, we had get a fine strain BT869, its serum type is determined to be H3a3b, belongs to the mutation of Bacillus thuringiensis. BT869 can make use of sucrose and lactose. When the Liquid is cultured motionless, a thick coat of bacteria film occurred on its surface. But the typic bacteria strain is not so. Hence BT869 is affirmed to be a new strain. BT869 is made of this strain containing many parasporal crystals and large granules. Its poisonousness is strong and can kiit the insect fastly and efficiently. There is a special efficiency to kill the insect of Lepidoptera, especially the fall webworm, but it is safe to the natural enemy and no pollution to environment.

STUDY ON SUPPRESSING EFFECTS OF USING TRICHOGRAMMA DENDROLIMI TO CONTROL 1st GENERATION OF ASIAN CORN BORER IN THE PLAIN AREA OF LIAONING PROVINCE. Zhuo Chang Xiao (Biotogicat controt Station of Liaozhong, Shenyang city, Liaozhong county, Liaoning province 110206) Bin Cong (Department of ptant protection, Shenyang Agricutturat university. shenyang, Liaoning province 110161 China).

Continued reteasing Trichogramma dendrotimi to Controt ist generation of asian corn borer (Ostrinia furnacatis)in ptain area has been carried out for about sixteen years in Changtan tiaoxzhong County, Liaoning province, Experiment resutts showed that the parasitizing rate of the egg of O. furnacatis was 70-85%, nearty as same as mountain areas where T. dendrotimi had been released to control tst generation of O. furnacati s continuatty. damage rate atso decreaed significantty year by year.

STUDIES ON THE RELATION BETWEEN RICKETTSIALIKE AND THE QUALITY OF TRICHOGRAMMA DENDROLIMI. Feng Zhang, Baoming Xu. Deshan Zhao (Station of Plant Protection, Xifeng, Liaoning 112400, China)

During the experiments of mass-rearing T. dendrolimi in 1991, rickettsialike organism and Staphylococcus sp. were found to affect wasp quality and quantity. The emerging rate viability and life span of adults infested decreased by rickettsialike. The number of deformed adults increased and most adults could not lay eggs or the eggs laid could not hatched. Larva and pupa which were infested could not develop. Staphylococcus infested larva and pupa of wasp by host eggs. The illed ones was smaller than normal ones. The lost eggs which were storaged in fridgerator made higher infestion than the fresh ones. When normal wasps were inoculated on the third emerging day, the emerging rate was over 95%, but when the illed was inoculated, only 50%. In order to solve these problems the host eggs used to rear wasps were dipped into sterillized liquid such as potassium permanganate, by which the emerging rates could be raised 12-22.3%. In addition, all the rooms were preserved cocoons. The room in which moth laid eggs and massrearing wasp should be sterillized in order to quarantee quality of wasps.

STUDIES ON THE SPECIES OF LEAF-ROLLING WEEVILS (ATTELABIDAE) IN LIAONING. Juan Li (Liaoning Academy of Forestry Sciences, Shenyang 110032, China)

The present paper is about leaf-rolling weevils (Coleoptera: Attelabidae) in Liaoning region. Twenty species belong to fourteen genera, seven tribes and three subfamilies of leaf-rolling weevils are described. Three species: Apoderus jekeli (Roel.), Leptapoderus carbonicolor Mots; Leptapoderus rubidus Mots. are new to Liaoning . A key to the genera, subgenera adn species known in Liaoning is given.

STUDIES ON THE FAUNA AND UTILIZATION OF STETHORUS WEISE (COLEOPTERA: COCCINELLIDAE). Huang Bangkan, Luo Xiaonan, Hong Shize (Department of Plant Protection, Fujian Agricultural College, Fuzhou, Fujian 350002, China)

Stethorus species are an important group of mite enemies on the fruit trees and economic plants. About 80 species of Stethorus are known all over the world, in which 28 spp. is distributed in Oriental, 13 spp. in Palaearctic, 14 spp. in Australian, 6 spp. in Nearctic, 11 spp. in Ethiopian, 16 spp. in Neotropical. It is known that about 20 species of Stethorus are distributed in China, in which 18 spp. in South China, 7 spp. in Middle China and Southwest China, 1 sp. in North China. There are 9 spp. of Stethorus from Fujian Province including 1 sp. new record to China and 1 sp. new to science.

The species of Stethorus have been used to control the mites in varying degrees in many countries. Especially in Pennsylvania, USA, the good result had been made by utilization of Stethorus punctum to control the apple red mite.

Since 1984 the successful control to citrus red mite by releasing Stethorus siphonulus Kapur has been achieved in about 20,000 mu citrus orchards in Fujian Province, China.

THE NATURAL ENEMIES AND SUPPRESSIVE FUNCTION OF ORIENTAL MOTH, CNIDOCAMPA FLAVESCENS (WALKER). Yanzhang Niu, Fuwei Wang, Changqi Gao, Hongyan Zhang (Forest Research Institute of Jilin Province, Changchun, Jilin 130012, China)

The natural enemies of oriental moth consist of 9 species in Jilin Province. These make the moth web of natural enemies and play an important role in the population dynamics, among them, Chlorocryptus coreonus Szeligeti is the dominant one, the parasitic percentage is 10-40% . The next one is Trichogramma dendrolimi Mats, the parasitic percentage is 10-37%. The parasitic percentage of the two main natural enemies is higher in old forest of than that in new one. C. coreonus can be immigrated from the old forest to the new one, trichogramma can be release twice during the egg stage of the moth so that the moth is effectively controlled.

A PRIMARY STUDY ON THE EFFECTS OF SOME ENVIRONMENTAL MATERIAL ON THE INFECTION RATE OF MOSQUITOES BY LAGENIDIUM GIGANTEUM (OOMYCETES:LAGENIDIALES). Xiao-qing Su(Guiyang Medical College,Guiyang,Guizhou 550004,China)

The effects of liver powder, sunflower seed powder, riceland soil, sand, mud from a barrel with stagnant water, and a species of algae (Ulothis spp.) on the infection rate of Culex quinquefasciatus larvae by Lagenidium giganteum were observed. The results showed that all those material except sand in the water increased the infection rate significantly, and there were more or less positive correlations between the amount of material in the water and the infection rate. An extensively saprophytic growth of Lagenidium giganteum producing excess zoòspores in liver powder and sunflower seed powder was observed and was thought to account for the increase of infection rates.

The results of comparing study about the effects of riceland soil, mud, and sand suggested that the fertility of soil might be the main factor causing the increase of mosquito infection rate. The possibility of saprophytic growth of the fungus in soil couldn't be excluded although no confirmative evidence has been found yet. The algae might be a water quality conditioner to provide a favorable environment for the action of zoospores.

STUDIES ON THE STRUCTURE OF THE WOLF SPIDER SUBCOMMUNITY IN CULTIVATED LAND. Yong-qiang Zhang,(Guangxi Agricultural College,Nanning 530005,China)

In this paper,the structure of wolf spider subcommunity at nine habitats of cultivated land in Nanning areas is discussed. 5221 individuals of wolf spider were collected,which includes 7 genus and 37 species. Among them,the Pardosa pusiola, P.pseudoannulata, P.venatrix, Pirata subpiralicus, P.piraloides and Trochosa ruricola are the major components of wolf spider subcommunity in cultivated land in Guangxi. The diversities and species richess of wolf spider subcommunity were maximum in citrus orchard, but minimum in paddy field in Nanning areas. The difference between the diversities, evenness, species richess and the dominant concentration at nine habitals of wolf spider subcommunity are very significant. By using similarity of the number propotion for community and analysis FUZZY method, showed that main components of wolf spider subcommunity were P. pusiola and T. ruricola in arid land, P. pseudoannulata and P.subpiraticus in paddy fidld,respectively.P. venatrix was the component both in arid land and paddy field. These components are quite typical of wolf spider subcommunity in the two types in main habitats of cultivated land in Nanning areas.P.pusiola and T. ruricola were dominant population in Nanning areas.P.pusiola adults activity peak occurs in May.

STUDY ON THE EFFECTS OF NATURAL ENEMIES ON DENDROLIMUS PUNCTATUS AND THE TECHNIQUES OF THEIR PROTECTION AND UTILIZATION. Xi Fusheng (Guangxi Forest Research Institute 23,Yongwu road,Nanning Guangxi 530001, China)

This research was conducted during 1982-1990 in the stand of Pinus massoniana heavily damaged by 3-4 generations of Dendrolimus punctatus per annu. in Southen part of Guangxi province,China.Results of systematic investigation showed that due to the effects of natural enemies, wind, rain and other factors the natural survival rate of the 1st to 3rd instar larvae of D.punctatus was only 9.34% in average. Silvicultural measurement such as closing hill for forestation, establishing mixed forest and protecting bee plants favoured the existence and reproduction of natural enemies and the self-controlling function of pine forest system to pests.During the stages of 4th to 5th instar larva of D.punctatus, introduction and release of Carcelia rasella increased the parasitic rate of the pupa by 56.88%, the percentage of the pupa eaten reached 76.40% by artificially introducing Cremastogaster dohrni artifex (200nests ha.) into the experimental stand, and the density of the immature instar larva was well controlled by introducing ptyrhachis dives (300nests ha.).The percentage of Parus major attracted by hanging man-made nests, reached 37.77%. The effect of controlling D.punctatus could also be improved by the protection of other less serious pine forest pests that could provide the natural enemies with food.To make full use of the natural enemies the area applied with chemicals should be less than 2% of the total under management, and effective, less residual and low toxic chemicals should be used mainly for controlling the pest origin-area. Meanwhile more attention should be paid to the time and method of chemical application.It is suggested that controlling measures over the Dendrolimus punctatus should be taken in the 4th instar larvae stage.

ENEMIES CATALOG OF ARMYWORM, LUCARNIA SEPARATA WALKER. Guangan Yang (Plant Protection Station, Dongliao County, Jilin 136600, China)

China is rich in insect enemies of armyworm of which the catalog were compiled after preliminary surveying from 1978 to 1985. There are 5 orders, 25 families and 100 species parasitizing and preying on armyworm. According to pest stages, there are 8 species in egg period, 76 in larva period, 16 from larva to pupa. They are belonged to 23 species in Ichnemonidae, 13 in Braconidae, 8 in Chalcididae and in Carabidae, 2 in Coccinellidae and in Telenomus. 26 in Tachinidae, and 18 others in different families. All these species are described in the paper. There are 8 dominate species which are dispersed in largeareas and can efficiently control armyworm. The protection of these enemies was discussed in present paper.

THE ERADICATION OF AEDES AEGYPTI (L.) APPLYING BIOCONTROL MEASURES IN GUANGXI, CHINA. Jian-ren Huang, Ji-Long Li(Guangxi Anti-epidemic and Hygiene Station, 80 Tao Yuan Road, Nanning 530021, China)

The distribution of Aedes aegypti (L.) in Guangxi was confined at Qisha township of Fancheng county; Satian township of Heu county; Weizhou island; Waisha, Gaode, Dijiao and the west part of Beihai city. From 1986 to 1990, an eradication programme on A. aegypti (L) in Guangxi was launches out, the measures were:(1), Clarias fuscus was breeded in household water containers in the whole infected area. (2) Cleaning the breeding place of A. aegypti (L.) and regular check up 2-3 times per month was made. And the useless containers will be turned upside down to prevent water accumulation, and cleaned all broken containers, (3) Health education, (4) Scientific administration and following strict surveying system.

Since we persisted in applying this system, the Breteau index was decreased to zero within 1 year, and kept a sustained negative container index up to now (Dec. 1990) in Guangxi, China.

NATURAL CONTROL TO CITRUS PESTS BY SPIDERS IN CHINA. Heng-mei Yan, Hong-quan Wang, Hai-min Yang (Department of Biology, Hunan Normal Uni versity, Changsha 410006, China)

At least 197 species, 88 genera and 25 families of spiders were collected from the citrus groves of 12 provinces in South China during 1982-91, in which 89 species and 8 families have not been reported previously from China. The spiders were found in variety of habitats where were much near those of the citrus pests, and the curves of seasonal change in number of the pest mites and the spiders are essentially similar (r=0. 5824 **) . In the fields and the laboratory, it was observed that the sac spiders mainly preyed on Panonychus citri (killed 29.3 mites/spider/day, at spider: mites=1: 50) , Adoxophyes cyrtosema(8. 6 insects/spider/day, at S: I=1: 10), Aleurocanthus spiniferus adult (8.4/day, at 1:10) , Phyllocnistis citrella adult (7.9/day, 1:10), Contorinia citri adult (8.8/day/, 1:10) and citrus aphis, scale etc. The function response of the spider Clubiona reichlini 2nd instar spiderling to P.citri was the Holling II type. The quantitative studies of the predation on the citrus pests by the precipitin test and electrociency was over 80% . The optimum temperature for the predation is 30℃, below 15℃ or over 40℃ the efficiency was very low. The results can be described by the eqution, $Na=0.0891(T-30)^2+24.8754$.

PROTECTING AND UTILIZING THE RESOURCE OF NATURAL ENYMIES FOR RICE AND CITRUS PESTS CONTROL. Chang-chu Zhou (Crop Pests Forecasting Station of Hunan Changsha, 410127, China)

There are 385 species of natural enymies in rice paddy, Consists of 283 species insects, 117 spiders and 5 other animals, among them 23 dominate species, inveestigated and identified in 1979-1983. In 1978-1990 XiangYin County had carried out a new rice pest control strategy called "protect spiders to control pests", protecting measures 1. Use sellective pesticides rationally 2. Remain grass and plant beans on the paddy sides. Extnted 430000 mu. Citrus red mite(Panonychus citri) is a serious damaged pest, occurred about a million mu each year in Hunan. The natural enymies of P. citri 54 species. Include phytoseiid 34 species, stethorus 7, chrosopiid 2, spiders 10 and thrips 1. The dominate species of phytoseiid is Amblyseius deleoni. studied on biological charaeters and feeding technique of A.deleoni. while Qian Yan, Xin Lin, Dong An county carried out the test of protecting predacious mites for control P. citri. Three measures 1. Remain non-damaged grass or plant peanut beans, vegetables, Particularly introduced and plant white flower grass (Ageratum couyzoides) 2. Rationally use sellective pesticides.3 Introduce and help to increase the density of predacious mites in the citrus orchard 1988-1990 extented 457000 mu.

PRIMARY STUDIES ON BIOLOGIACL CHARACTERS OF PROREUS SIMULANS STÅL(DERMAPTERA: CHALISOCHIDAE). Zong-dian Wang. Yang-chu Gong, Xian-fu Shuai, Da-zhi Wang (Hanshou Institute of Reed Science, Hunan 415900, China)

Proreus simulans Stål is a predatory natural enemy to control of the pests on reed fields. The biological characters of the chelisochid have been studied on. There are two generations in a year in Hunan. The adult and nymph hibernated on the remaining stems and leaves of reed, or in the siol chinks. The adult's longevity is about 4 months in first generation and at least 10 months in next one. The sex rate is about 5: 4. The coupling behaviour could repeatedly carry out for male or female abults. The ovipositing number average 39.2 per female. The eggs period average 6.5 days and hatch at night. The adultsand nymphs of chalisochid prey upon some species of insect pests of reed, such as: larvae or pupae of Melanaphis sp., Thrips oryzae, Oligonychus sp., Sesamia sp., Chilo niponella, Leucania separata and the eggs of Dimorphopterus spinolae. The maximum predatory number per a chalisochid abult at one day follows various preys, as follows: aphids 203.5, thrips 161, mites 156.5, noctuids 16.

TECHNIQUES TO CONTROL OSTRINIA FURNALALIS BY TRICHOGRAMMA DENDROLIMUS. Fuhua Zang (Plant Protection Station, Huairou, Beijing 101400, China) Guoqiang Li (Beijing Plant Protection Station, Beijing 100029, China)

Some techniques for mass-rearing and releasing T. dendrolimi have been studied since 1978. 1.The optimum conditions to rear wasps are 25-27℃ , 80-90% RH and 15 wasps per squre centimeter parasitizing 30 minutes on host egg card. 2. The relation between conserving wasps under 0-5℃ and emergencing rate of wasp is negative, regress equation is y=55.5-0.5524x. 3. It has positive relation between time of host wing's unfolding and the rate of egg-maturing, y=76.31+0.55x.

When artifitial rearing wasps were released, the parasitism at corn borer egg stage of the second generation is more than 70% (69-98%).

A PRELIMINARY REPORT ON THE SELECTION OF FINE GEOGRAPHIC POPULATION OF TRICHOGRAMMA DENDROLIMI. Fan Zhang, Ton Sun, Guangzhi Sun, Zhongyou Li (Biological Control Laboratory, Modernization Institute, Jilin Agricultural Universtiy, Changchun 130118, China)

A series of tests and observations were carried out of the population biology and ecology of different geographic populations of T. dendrolimi collected from different regions. As a result, one of them, HLT, was selected to be mass produced to control the Asia corn borer, Ostrinia furnacalis. This population has a lower threshold temperature (3.87℃ for egg, 3.90℃ for larva, 7.80℃ for pre-pupa, 11.80℃ for pupa), lower thermal total for developing from egg to adult (729.4 day degree under 15℃, 516.0 day degree under 20℃, 273.7 day degree under 25℃) , higher reproductive ability and better resistance to unfavorable environmental conditions.

NEW TECHNIQUES FOR THE MASS PRODUCTION OF TRICHOGRAMMA DENDROLIMI. Fan Zhang, Tong Sun, Guangzhi Sun, Zhongyou Li (Biological Control Laboratory, Modernization Institute, Jilin Agricultural University, Changchun 130118, China)

New techniques have been developed for the mass production of T. dendrolimi. These techniques include: Selection of higher quality of T. dendrolimi strains. automatic control of rearing conditions with self-made electrical automatic control instruments, control of wasp's diseases and 2 new kinds of machines, which was for clearing out the immature tassah worm eggs, another one was for differentiation and separating parasitized host eggs. Parasitism and emerging percent were raised from 75% to 90%, and the rate of immature host eggs decreased by 7% (from 10% to 3%) with the new techniques. 87 billions wasps were produced from 1989, they were released in 5.8 millions mu (386667 ha.) corn field to control Asia corn borer, Ostrinia furnacalis. It brought in an income increase of 21.5 millions.

Mass production and utilization of *Trichogramma* 12. Improved method for rearing the host *Sitotroga cerealella*. S.A.Hassan, Institute for biological pest control, Heinrichstr. 243, D-6100 Darmstadt, Germany.

A rational method for the mass production of the Angonomois grain moth *Sitotroga cerealella* (oloiv.) was developed and tested for more than 15 years. Experience with the method was also gained by two commercial producers in the Federal Republic of Germany since 1980, 1983 as well as by colieagues in Portugal, Egypt and Argentina. Manual work and exposure to wing scales of the moth is reduced by mechanization and by providing air suction filters in several steps of the operation. Increased production is achieved by optimizing rearing conditions.

Sitotroga adults emerging from rearing units holding about 100 kg wheat are collected into cylindrical cages with wire gauze walls. The adult emerging units are constructed to provide optimal conditions for the larval development and to prevent the accumulation of heat. The gathering and cleaning of the eggs are carried out by fitting the moth cages into semi-automatic egg laying units. In these, the cylindrical cages are rotated at intervals, their outer walls being cleaned by a built-in suction system that simultaneous remove the moth wing scales. The cleaned eggs fall through bottom openings and are collected into trays.

Influence of Understory Cover and Surrounding Habitat on Interactions between Beneficial Arthropods and Pests in Orchards/Vineyards

CLIMBING A LADDER OF INTEGRATION IN ORCHARD PEST AND HABITAT MANAGEMENT. Ronald J. Prokopy (Dept. of Entomology, Univ. of Massachusetts, Amherst, MA, 01003, U.S.A.)

Progress in integrating practices for managing pests of orchards and other crops can be viewed as analogous to climbing steps of a ladder. Usually the top step is achieved only by advancing up the ladder step by step. With pest management, it is unlikely that a high level of integration of effective practices can be attained without first achieving lesser levels of integration. In my view, the first level of integration involves development of ecologically sound multiple management tactics for a single class of pests: either arthropods, diseases, weeds or vertebrates. The second level concerns integration of multiple management practices across all classes of pests. The third level embraces integration of management approaches across the entire system of crop production (equivalent to integrated crop management). The fourth and highest level involves blending the concerns of all of those with a vital interest in the pest management process: researchers, extension personnel, private consultants, industry, growers, consumers, environmentalists, and government. Progress up a ladder of integration becomes increasingly difficult with each step taken.

In management of orchard understory and surrounding vegetation, one might design a strategy consisting of a suite of effective practices for encouraging buildup of beneficial predators and parasitoids of pest arthropods under a first-level IPM approach. Under second-level IPM, however, such a strategy might be severely compromised or collapse in the face of a conflicting integrated strategy for managing diseases or weeds. Advancing to third and fourth levels of IPM could pose even greater conflicts. This presentation will focus on challenges associated with orchard habitat management as one attempts to climb a ladder of integration in pest management approaches.

APPLE AND CHERRY ARTHROPOD MANAGEMENT IN RELATION TO ORCHARD FLOOR VEGETATION IN UTAH. Diane G. Alston (Department of Biology, Utah State University, Logan, UT 84322-5305), William M. Coli (Department of Entomology, University of Massachusetts, Amherst, MA 01003).

To determine the influence of orchard ground cover composition on arthropod pest and natural enemy abundance, commercial Utah orchards with different cover types were surveyed in 1989-91 and cover crop treatments were established in a research orchard. Ground cover had a significant effect on both phytophagous and predatory mite densities, and the timing and synchrony of their dispersal into trees. Spider mite populations in trees increased to economically damaging levels in orchards with 65-95% bare ground and required one to two acaricide treatments. Acaricides were not required in orchards with less than 50% bare ground, and with ground cover vegetation consisting of grass or grass/broadleaf weed mixtures due to a buildup of predatory mites in trees. Herbicide treatments applied in mid-summer to control field bindweed in tree rows increased phytophagous mite densities in trees and disrupted the synchrony of predator/prey ratios. Significantly greater densities of arthropod herbivores, predators, and parasitoids were collected in orchards with an alfalfa, subclover, or weed cover than in plots with grass or bare ground.

MANAGING COVER CROPS TO MANAGE PESTS. Robert L. Bugg (Information Group, Sustainable Agriculture Research and Education Program , University of California, Davis, CA 95616-8533, U.S.A.), H. M. A. Thistlewood (Agriculture Canada, Research Branch, Research Station, P. O. Box 6000, Vineland Station, Ontario, L0R 2E0, Canada)

Orchards are subject to attack by both specialist and generalist phytophagous arthropods. Cover crops represent an important nexus in sustainable orchardry, and may affect many aspects of production, including management of these potential pests. Cover crops may potentially be used to: (1) divert various generalist pests,(2)confuse specialist pests visually or olfactorally and thus reduce their colonization of orchard trees, (3) alter host - plant nutrition and thereby reduce pest success, and (4) change the microclimate thereby reducing pest success. These are aspects of cultural control. If cover crops are used to improve performance by natural enemies (e.g. parasites,pathogens,and predators) this is considered an aspect of biological control. At times , both cultural and biological controls may operate simultaneously; in other instances, their management requirements may conflict. Cover-crop management issues include plant material selection,fertilization, irrigation, mowing,and tillage. All of these may have implications for orchard pest management.

THE EFFECTS OF UMBELLIFEROUS UNDERSTORY PLANTS ON PARASITOIDS OF TORTRICIDS IN A NEW ZEALAND APPLE ORCHARD.

A.M. Henwood, R.R. Scott & R.B. Chapman (Department of Entomology, Lincoln University, New Zealand).

The parasitoid fauna of three small organically managed apple orchards was monitored over two seasons. The abundance and phenology of all parasitoids trapped was established, with particular attention to the parasitoids of tortricid pests. The understory comprised grass and flowering plants known to attract parasitoids. The dominant one was wild parsnip, *Pastinaca sativa*; other umbellifers were fennel, *Foeniculum vulgare*, wild carrot, *Daucus carota* and cow parsley, *Anthriscus sylvestris*. Other weeds present were dandelion, *Taraxacum officinale*, gold rod, *Solidago* sp., and yarrow, *Achillea millefolium*. Parasitoid presence was monitored using yellow pan traps and sweep nets during the 1990-91 and 1991-92 summers. Peak flowering and hence pollen and nectar availability in wild parsnip occurred before peak parasitoid populations were recorded. The management and possible use of additional or alternative umbellifers and wild flowers for enhancing parasitoids presence is discussed. The level of parasitism of the major pests of the orchards, codling moth, *Cydia pomonella*, and the leafroller complex was assessed and relationships between the trapped parasitoid fauna and the observed parasites of these pests is discussed.

VAGETATION DIVERSITY AND ITS RELATION TO PEST MANAGEMENT IN APPLE ORCHARDS IN THE BEIJING REGION OF CHINA. Yuhua Yan,D.Q.Chen, Z.W.Shi, B.G.Zhao,J.J.Duan,X.G.Du (Department of Plant Protection, Beijing Agricultural University, Beijing, 100094,China)

From 1985-1990,a cover cropping system for the purpose of enhancing the biological control of apple pests was practiced in the commercial orchard of Beijing State Farm. This system consisted of interplanting two species of the crops - the alfalfa ,Medicago sativae, and the rape, Brassica campestris, in the row of apple trees.They provided alternate food sources,refuge,and habitat for several important species of natural enemies played a significant role in suppressing the secondary induced pests.A variety of ground predators were found in the understory cover crops.The abundance of these ground predators was highly correlated with the predation of the several lepidopterous pests of apple orchard.In contrast to the orchard with no understory plant (clearing management),use of this cover-cropping system resulted in a reduction of pesticide use by 50% for the control of aphids and lepidopterous pests and 70% for spidermites.The cover-cropping system used in the experiment could be very important component of orchard IPM for the Beijing region. The relevance of this system to establishing a stable orchard ecological system was discussed on the basis of our findings.

INFLUENCE OF GROUND COVER PLANTS ON THE ARTHROPOD COMMUNITY IN CITRUS ORCHARD. Weiguang Liang, Mingdu Huang (Guangdong Entomological Institute, Guangzhou 510260, China)

In a study of the changes of environment, the abundance of citrus red mite, Panonychus citri (McG.) and its predaceous mite with the cultivation of the weed, Ageratum conyzoides Linn. in citrus orchards, Mingdu Huang et al (1978, 1981) found and suggested that effective integrated control of citrus red mite is possible when the weed is growing in citrus orchard. In the recent ten years, this work has brought about a new advance in the theory and practice of the integrated management of citrus insect pest.

1. In South China, more than 67000 hectares of citrus orchards have been planted or reserved ground cover grass, effective control of insect pest and the economical and ecological benefit have been obtained.

2. The relationship of the ground cover plants and the arthropods was studied.

a. The structure of arthropod community in citrus orchard ground cover plants was investigated.

b. The relationship of the arthropods in the ground cover plants and the tree canopy in citrus orchard was discussed.

c. The infuence of the ground cover plants on the numbers of species and the numbers of individuals in citrus orchards was observed.

XS-1

Influence of Understory Cover and Surrounding Habitat on Interactions between Beneficial Arthropods and Pests in Orchards/Vineyards

THE ROLE OF FLOWERING HERBS IN THE INTERACTION BETWEEN SYRHPIDS AND ROSY APPLE APHID IN GERMANY. Erich Dickler, Christine Perl, Martina Riege (Federal Biological Research Centre, Institute for Plant Protection in Fruit Crops, 6915 Dossenheim), Germany.

Amongst the 5 species of aphid that attack apple orchards in Germany, the rosy apple aphid (Dysaphis plantaginea) is the most abundant and destructive. Both adults and nymphs feed by sucking sap from the leaves which results in yellowing, curling and eventually premature leaf drop. Severe infestation results in stunting of affected branches which bear small and malformed fruit.

First field trials have shown that flowering herbs planted within the orchard or in the near vicinity, encourage populations of natural enemies of aphids. In particular, plots with Sinapis arvensis and/or Phacelia tenacetifolia were observed to have high populations of syrphids compared to those without. In addition, populations of rosy apple aphid were significantly lower in orchards planted with these herbs. Similar results were observed for, populations of the green apple aphid (Aphis pomi).

INTERACTIONS OF UNDERSTORY AND SURROUNDING VEGETATION ON MITE COMMUNITIES AND A PLANT BUG IN CANADIAN APPLE ORCHARDS. H.M.A. Thistlewood (Agriculture Canada, Research Station, Vineland Station, Ontario L0R 2E0, Canada)

The European red mite, Panonychus ulmi (Koch), and the twospotted spider mite, Tetranychus urticae Koch, are presently serious pests in commercial apple orchards of eastern Canada. The mullein bug, Campylomma verbasci (Meyer), is also a serious pest of some apple cultivars in some years. In the 1970's, many apple orchards supported a complex of organophosphate-resistant predatory mites, phytophagous mites were easily managed, but the mullein bug became a serious pest. Obvious changes have occurred in Canadian orchards since then due to the adoption of high density production, including more intensive ground cover vegetation management by mowing and herbicide use. Some effects of different orchard ground covers or the surrounding habitat on mite communities, and on mullein bug populations, are presented from apple orchards.

INFLUENCE OF SURROUNDING TREES AND BUSHES ON PHYTOSEIID MITE FAUNA ON APPLE IN FINLAND. T. Tuovinen (Institute of Plant Protection, Agricultural Research Centre of Finland, SF-31600 Jokioinen, Finland).

Species composition and densities of predaceous phytoseiid mites were compared in and around orchards in Southern Finland by collecting leaf samples from apple trees and from surrounding deciduous trees and bushes. Over 80 % of all identified specimens (ca. 7000) belonged to E. finlandicus (Oudemans) and Phytoseius macropilis (Banks). These species are considered to be the most important in the natural control of the European red spider mite in Finland. The effect of surrounding vegetation on phytoseiid mite densities and species composition on apple was noticeable. Phytoseiid mites occurred only occasionally in commercial orchards where only a few other deciduous trees of bushes were located nearby. However, phytoseiids were more abundant in orchards surrounded by suitable host plants, even if harmful insecticides had been used.

The phytoseiid mite density on apple averaged 1.5/leaf in a representative 2-ha orchard surrounded by many deciduous trees and bushes. Phytoseiid mite densities near that orchard ranged from 0.3 mites/leaf to 9.8/leaf, depending on the plant species. E. finlandicus dominated both on apple and on other host plants, except honeysuckle. No reliable evidence of resistance to dimethoate, the OP-insecticide used in that orchard, was found in specimens collected either on apple or surrounding hazel bushes during preliminary laboratory tests.

UNDERSTORY EFFECTS ON PREDATORY MITES IN MASSACHUSETTS APPLE ORCHARDS. William M. Coli (Department of Entomology, Fernald Hall, University of Massachusetts, Amherst, MA 01003 USA).

Twenty-eight commercial apple orchard blocks were divided into one of four groups depending on tree row groundcover management strategy, and effect of pesticides used on predatory Phytoseiidae and Stigmaeidae. Groundcover and block border composition were determined using ordination.

Field assistants gathered pooled samples of the top 5 most frequently occurring plants at selected aisle and row sampling sites, and subjected samples to a careful 2-minute scan with a 10X hand lens. In addition, 10 randomly-selected leaves were picked from an apple tree at each sampling site, and carefully scanned. Presence or absence of phytophagous and predatory mites was recorded, and specimens collected.

Data are presented on: Composition of orchard groundcovers and block borders; Differences in orchard groundcover composition between tractor aisles and tree rows; Effects of orchard spray program classification on phytophagous and predatory mites in apple trees, and; Frequency of occurrence of phytophagous and predatory mites on different groundcover and border plants. Continuing studies of understory effects on orchard mites are described, and implications for biologically-intensive Integrated Pest Management programs are discussed.

USE OF SIMULATION MODELS FOR STUDYING FACTORS THAT CONTRIBUTE TO PERSISTENCE OF MITE PREDATOR-PREY SYSTEMS. J. P. Nyrop. (New York State Agricultural Experiment Station, Cornell Univ., Geneva, NY 14456, USA)

The persistence of the European red mite *Panonychus ulmi* (Koch) and its predator, *Typhlodromus pyri* Scheuten was studied emperically at two geographic locations and at two spatial scales. At the scale of an orchard, both *P. ulmi* and *T. pyri* were persistent over the time frame of 6 years. At the scale of an individual tree, *T. pyri* appeared to be more persistent than its prey, *P. ulmi*. A simulation model of single populations of *P. ulmi* and *T. pyri* was used to determine which of several aspects of the biology of the two species could contribute to such a pattern. Spatial incongruity between predator and prey was essential for persistence of both species. The generalist food habit of *T. pyri* probably contributes to the persistence of *T. pyri* on individual trees, and may cause occasional extinction of *P. ulmi* at this spatial scale. The presence of alternate food is likely an essential element for successful biological control in this system. Cannibalism by *T. pyri* results in higher prey densities, that is, it is detrimental to the biological control of *P. ulmi*, but has no effect on the relative persistence of the two species.

APPLE ORCHARD CHARACTERISTICS AFFECTING ABUNDANCE OF PEST MITES AND MITE PREDATORS IN ARKANSAS, USA. Johnson, Donn T. (Department of Entomology, University of Arkansas, Fayetteville, AR, 72701, USA), Curt R. Rom and Mark A. Den Herder (Department of Horticulture & Forestry, University of Arkansas, Fayetteville, AR, 72701, USA)

An interdisciplinary team surveyed 12 apple orchards. European red mite (ERM) Panonychus ulmi (Koch) and predatory mite (PM) Amblyseius fallacis (Garman) were in 100% and 91% of orchards. Predatory stigmaeid mite and PM populations first appeared and peaked on apple leaves earlier in orchards with an understory of weeds than bare cover. Positive correlations existed between number of applications per season of non-selective insecticides and miticides and date PM populations peaked in orchards. Blocks of 'Jersey Mac', 'Red Delicious', and 'Red Rome' all on MM-111 surrounded by bare soil realized 1389, 1065, and 668 cumulative mite days (CMD), respectively. Understory cover affected ERM populations only in 'Red Delicious' blocks where understory covers were bare soil, bare soil with a 45 cm fescue grass strip linking the trunks, and weedy yielding 1065, 920 and 582 CMD, respectively. Residual-leaf-dip bioassays identified ERM populations resistant to most miticides registered in USA for apples. All ERM were resistant to fenbutatin-oxide and susceptible to fenpropanate.

BIOINTENSIVE MANAGEMENT OF INSECT PESTS OF RICE. R.C. Saxena (ICIPE, P.O. Box 30772, Nairobi, Kenya)

More than 200 species of insects attack irrigated rice but less than one-tenth cause any significant crop loss. Integrated management of rice pests advocating need-based insecticide application and relying on environmental resistance factors has been successful. A logical next step would be a pesticide-free approach. Here I discuss the prospect of biointensive rice pest management based on pest-resistant or tolerant cultivars, conservation and augmentation of pests' natural enemies, use of plant-derived pest control agents, and appropriate cultural practices. Such an approach also should conserve and promote bio-diversity in rice agroecosystem.

DEVELOPING A LOW DOSE PESTICIDE MANAGEMENT STRATEGY AS A COMPONENT FOR RICE IPM IN THE PHILIPPINES. S.M. Bato, J.S. Soriano, Jr., F.V. Palis, J.I. Calderon and F.A. Ceballo (National Crop Protection Center, University of the Philippines at Los Banos, College, Laguna, Philippines). Field experiments were conducted for 5 seasons beginning in the 1989 wet season until the 1991 wet season planting at strategic sites in the rice producing areas of Luzon, Visayas and Mindanao Island. The objective was to evaluate the practical usefulness and profitability of different pest management strategies under farmers's field conditions in the Philippine rice production system. This article present the results obtained and the benefits that can be derived from a strategic insecticide application tactic (SIAT) employing low dosage pesticide and correct time of application based on the natural population dynamics of the insect pests and increased farmer's income. The importance of the SIAT strategy as a pesticide management component of integrated pest management in lowland transplanted rice is presented.

SOME SUBSTANTIAL ISSUES ON INTEGRATED DISEASE & PEST CORTROLS. Zhengwen Tu (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences, Nanjing 210014, China)

The integrated disease & pest control (IDPC), a new strategy enriched in knowledges and techniques, has an epoch in the development of plant protection science and technology. Its inner meanings and influences have drawn widespreading attention internationally. A large scale of studies on the IDPC have managed to be gradually advanced in our country, just as in other parts of the world since nineteen eighties.

With key programmes of the national 6th and 7th five-years scientific and technological reseaches, a great deal of work has been done upon the integrated rice disease and pest controls. Of these, some substantial issues as follows are to be surpassingly analyzed so that comprehensive apprehension at the issues and better evaluation on the IDPC would be reached, which would further promote the IDPC itself to progress.

1. Appearance of the IDPC;
2. Inner meanings of the IDPC system;
3. Relationship between target and index of the IDPC;
4. Characteristics of key techniques of the IDPC;
5. Post-evaluation and prospect of the IDPC.

PUTTING INDUSTRY'S IPM TRAINING AND EXTENSION RESPONSIBILITIES INTO PRACTICE IN DEVELOPING COUNTRIES. W.T. Vorley (Farmer Support Team, Plant Protection Division, Ciba-Geigy AG, CH-4002 Basel, Switzerland)

The potential benefits of IPM to farmers and environment are well documented. But the agrochemical industry can also profit in the long term by assisting farmers to make the change from overreliance on pesticides towards sustainable pest management. More directed and selective use of agrochemicals within IPM systems results in resistance management, longer product life, improved grower satisfaction and minimum operator contamination.

In practice this change of strategy requires more than the launching of new "IPM-compatible" products. Research priorities, sales language, product information (including labels) and customer training must all be critically reviewed. Such reviews are most urgently needed in developing countries, where the private sector may be the only available source of farmers' pest control information, but where companies are most reluctant to invest due to small profit margins and the formidable logistics of influencing thousands of scattered small scale growers.

The development of such a strategy for rice, vegetables and other tropical crops is described, stressing minimum doses or action thresholds and conservation of indigenous natural enemies. For extension, a social marketing approach will be employed for improving farmers' pest/beneficial recognition skills, understanding of natural population regulation, pesticide application quality and personal protection.

WHITEFLY VECTORS: INCREASING THREAT TO WORLD AGRICULTURE. James E. Duffus, (USDA-ARS, U.S. Agricultural Research Station, Salinas, California.)

The whitefly-transmitted viruses produce a wide and divergent group of diseases, most of which have not been characterized. The agents are transmitted by at least three whitefly species in the nonpersistent semipersistent, persistent, and by biological mechanisms. The viruses cause significant losses throughout the world and are responsible for some 70 important diseases in the tropical and subtropical areas. Recent years have shown an increase in losses in wide areas north and south of the tropics, approaching areas of intensive agricultural production. The whitefly-transmitted diseases have been characterized in general on the basis of their transmission by whiteflies and the activity of the agents on host plants, such as symptoms and host range. A compilation of available data on the viruses themselves would suggest at least seven groups of viruses differing in type of virus particle, symptom type, and vector relationships. These include geminiviruses, and viruses similar to the closteroviruses, caraviruses, potyviruses, nepoviruses, luteoviruses and a DNA-containing rod-shaped virus. Recent changes in importance and world distribution of *Bemisia* seems to be related to movement and displacement of biotypes or species.

TOMATO SPOTTED WILT VIRUS AND THRIPS ANATOMY: JOURNEY INTO THE MICROCOSMOS. Diane E. Ullman, Ronald F. L. Mau, Daphne M. Westcot (Department of Entomology, University of Hawaii, 3050 Maile Way, Rm 310, Honolulu, HI 96822), John J. Cho and Diana M. Custer (Department of Plant Pathology, University of Hawaii, Maui Branch Experiment Station, P.O. Box 269, Kula, HI 96790)

Presentation of Terebrantian internal morphology will provide a map for further exploration of tomato spotted wilt virus (TSWV, formerly TSWV-lettuce strain) inter- and intracellular translocation in one vector species, the western flower thrips (WFT), *Frankliniella occidentalis* (Pergande). Light, scanning and transmission electron microscopy evidence characterizing the alimentary canal, salivary glands, fat body and ovaries will be presented and compared to findings by other investigators.

Evidence from electron microscopy suggests that internalization of TSWV by midgut epithelial cells of WFT apparently occurs in smooth, close fitting vesicles as suggested for receptor mediated endocytosis of simian virus-40. By analogy to other members of the Bunyaviridae, TSWV translocation is probably reliant upon receptor mediated events in which virus membrane glycoproteins play a critical role. Virus particles and paracrystalline arrays have been observed in the midgut epithelia, fat body, nerve cells, brain and salivary glands of viruliferous thrips, suggesting wide spread infection of thrips cells underlies thrips infectivity.

The role of virus translocation and cellular events governing virus replication and degradation will be discussed in light of thrips vector specificity and TSWV epidemiology.

TENUIVIRUSES OF PLANTS AND INSECTS, AND THEIR SIMILARITIES TO INSECT-TRANSMITTED VERTEBRATE VIRUSES B. W. Falk, L. Huiet, Plant Pathology, University of California, Davis,. USA 95616. J. H. Tsai, FLREC, University of Florida, Florida, USA 33314.

Tenuiviruses are important pathogens of monocots including rice and maize. They are transmitted to their plant hosts by Delphacid planthoppers, which also are hosts for these viruses. We have characterized a large portion of the maize stripe tenuivirus (MStV) genome (5 RNAs totalling 18 Kb), and analyzed MStV-infected plants (Zea mays) and planthoppers (Peregrinus maidis) for MStV genome and protein components. Detailed analyses of MStV RNAs 3 and 4 have shown that these are very abundant in infected Z. mays, as are subgenomic RNAs presumably involved in MStV gene expression. One MStV gene product encoded by RNA 4, the major noncapsid protein (NCP), is the most abundant protein in MStV-infected Z. mays yet not detected in infected P. maidis. Similarly, the putative mRNA for the NCP is not readily detected in infected P. maidis. The organization and expression strategies for RNAs 3 and 4 is strikingly similar to those of invertebrate-borne viruses of vertebrates including uukuviruses and phleboviruses. Similarities and possible phylogenetic relationships between tenuiviruses and invertebrate-borne viruses of vertebrates will be discussed.

POTENTIAL EFFECT OF GLOBAL WARMING ON THE EPIDEMIOLOGY OF INSECT-BORNE VIRUS DISEASES. Shun'ichi Miyai (Tohoku National Agricultural Experiment Station, Akahira, Morioka, Iwate 020-01, Japan), Keizi Kiritani (Food & Fertilizer Technology Center, 14 Wenchow St., Taipei, Taiwan, China)

Temperature is an important factor influencing insect vector population biology and behavior, such as survival, longevity, development, dispersal and feeding.

Examination of the threshold of development (T_0) and the effective cumulative temperature for the completion of development (K) for insects of different taxonomic groups indicated that aphids are the insect group with the lowest values of both T_0 and K. This characteristic suggests that aphids, which are the most important vectors of plant virus diseases, will be highly efficient in taking advantage of global warming in their propagation.

Using a mathematical epidemiological model for insect-borne virus diseases, the effect of rising temperature on the extent of epidemics was evaluated for persistent and nonpersistent viruses. Expected devastating effects will be evaluated by some computer simulations.

ENVIRONMENTAL AND SAFETY ASPECTS OF GENETICALLY ENGINEERED VIRAL AND MICROBIAL INSECTICIDES. Karl Maramorosch (Department of Entomology, Cook College, Rutgers-The State Universty, New Brunswick, New Jersey 08903, U.S.A.)

Environmental safety of genetically engineered viral and microbial biocontrol agents must be based on the knowledge of evolutionary biology, population ecology, molecular biology and genetics. Environmental perturbations that can result from the use of novel bioengineered pathogens include displacement or destruction of beneficial insects and cumulative effects that may affect the environment. Among the major risks is the development of insect resistance. The risks are speculative and positive effects of engineered biological agents by far outweigh the negative ones. Therefore, genetically engineered biocontrol agents may soon replace dangerous chemical insecticides and provide important ecological benefits. Bio-engineered viral and bacterial insecticides can be combined with small amounts of chemicals in integrated pest management programs to further maximize the insecticidal effects. Genetically engineered biodegradable viruses and bacteria will create safe and effective insecticides that are environmentally sound, economical, and applicable to diverse agricultural conditions.

EPIDEMIOLOGY AND ECOLOGY OF APHID BORNE NON PERSISTENT VIRUSES B. Raccah, Virology, The Volcani Center, A.R.O. P.O.B. 6, Bet Dagan, 50-250, Israel.

In most plant virueses, the classical epidemiological triangle (hosts, pathogens and environment) is complemented by vectors. Aphids are the most common vector for plant viruses. The relative importance of individual aphid species has been determined by their incidence (in flight and on vegetation), by their intrinsic transmission capacity, and by their landing on the crop and the tendency to remain on it. Economical losses caused by non persistent virus (NPV) motivated intensive work on peppers (CMV and PVY), on soybens (SMV) on tobacco (TEV and TVMV) on cucurbits (CMV, WMV2, PRSV-W and ZYMV) and on stone fruits (PPV) throughout the world (reviewed by Raccah, 1986). Despite the low specificity of NPVs for aphid species, field studies have shown that few species only are involved in spread. Reasons for differential vectorial efficiency of aphid species has been attributed to their interaction with the host. Indeed, recent studies has shown that settling and desertion of hosts are affected by certain plant volatiles (Goffreda et al., 1989). Another factor which may modify spread is the interaction between aphids and viruses. This was demonstrated by transmission of a non aphid-transmissible isolate of ZYMV when complememted with coat protein subunits or helper component produced by another virus or virus isolate (Lecoq et al. 1991a, b). The implication of these findings in the epidemiology and ecology of aphid-borne viruses is discussed.

PLANTHOPPER AND LEAFHOPPER BORNE PLANT VIRUSES IN EUROPE
Maurizio Conti (Istituto Fitovirologia Applicata, 10135 Turin, Italy)

Barley yellow striate mosaic rhabdovirus (BYSMV), wheat dwarf geminivirus (WDV), and the reoviruses maize rough dwarf (MRDV), cereal tillering disease (CTDV) and oat sterile dwarf (OSDV) are the hopperborne plant viruses occurring in Europe whose physico-chemical, structural and epidemiological characteristics have been determined sufficiently for proper identification. The geminivirus beet curly top (BCTV) also seems to occur in the mediterranean area but its presence in Europe is not yet proven. BYSMV, MRDV, CTDV and OSDV are transmitted by delphacid hoppers, or planthoppers, while WDV is trasmitted by a cicadellid species, or leafhopper. In all cases transmission is of the circulative type but virus multiplication in the vector has been demonstrated only for the four former viruses, while transovarial transmission has been found only for BYSMV. Serological and/or genomic studies have established that viruses closely related to BYSMV on one hand, and to MRDV, CTDV and OSDV, on the other hand, exist in various parts of the world where they are transmitted either by the same or by different vector species. The characteristics of each group of viruses are compared and briefly discussed.
Several leafhoppers in Europe also transmit MLO-associated plant diseases, some of which have caused severe outbreaks in the last few years. The most important of them, such as grapevine flavescence dorée, tomato big bud, and elm yellows are described.

INSECT AND PLANT VIRUSES IN BEETLE VECTORS. K.S. Kim, R.Y. Wang, and R.C. Gergerich. Dept. of Plant Pathology, University of Arkansas, Fayetteville, Arkansas, U.S.A.

Beetles in Chrysomelidae, Coccinellidae, Curculionidae and Meloidae are important plant virus vectors transmitting specific groups of plant viruses. The movement of some plant viruses into the hemolymph in Chrysomelid beetles has led to the generalization that beetle-transmitted viruses are circulative. However, recent studies with two beetle-transmitted viruses in the Mexican bean beetle, a representative of Coccinellidae, revealed no movement into the hemocoel. This indicates that circulation of plant viruses in beetle vectors is not required for transmission. Ultrastructural studies revealed that plant viruses introduced into the hemocoel of beetles were readily phagocytized by hemocytes. All types of hemocytes including granulocytes were phagocytic. In addition, various types of insect viruses including reo-, baculo-, entomopox-, picornaviruses and an unidentified filamentous viruslike particle were consistently found in hemocytes and midgut epithelial cells of the bean leaf-, spotted cucumber- and Mexican bean beetles. The reovirus found in Mexican bean beetles appeared to be transovarially transmitted as evidenced by the presence of virus particles in the sperm head as well as in meiotic oocytes.

PUTTING ECOLOGY INTO PLANT VIRUS CONTROL STRATEGIES.
Michael E. Irwin, (University of Illinois and Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, IL 61820, U.S.A.)

Integrated pest management (IPM) is that applied field by which incidences of diseases and population densities of other pests are maintained below economic thresholds. IPM is based on fundamental knowledge, i.e., understanding the taxa under consideration, the basic biology of the taxa, a means to determine the incidence and population levels of the taxa, and crop losses attributable to each taxon. To that foundation, tactics (chemical control, host plant resistance, biological control, cultural practices, legal control, and a host of other, less obvious, measures), are developed to reduce, retard, or delay incidence or lower population densities of pests below economic thresholds. The capstone of IPM is the implementation of a single, integrated strategy to minimize yield losses and minimize environmental degradation and health hazards.

Plant virus epidemics are complex, involving interactions between viruses, their host plants, and their vectors, and between the vectors, their host plants, and the pervasive environment. In this paper, two aphid-borne viruses will be reviewed: soybean mosaic virus, a potyvirus that is transmitted nonpersistently, and barley yellow dwarf virus, a luteovirus that is transmitted circulatively (persistently). The epidemics will be dissected with a view towards understanding the role each of the tactics can play in an ecologically constructed strategy to reduce, delay, or restrict virus epidemics.

PLANTS, INSECT VECTORED PLANT PATHOGENS, AND NON-VECTOR INSECTS: AN OVERVIEW. Fernando E. Vega and Pedro Barbosa, (Department of Entomology, University of Maryland, College Park, MD 20742, USA)

A review of the literature shows that most insects found feeding on diseased plants are not capable of vectoring plant pathogens. Out of 111 studies dealing with insect-vectored plant pathogens, only 6 have looked at the effect of the pathogen on some life history parameter of the non-vector insect. Possible effects on non-vectors could be direct (e.g. reduced fecundity, longevity, cytological aberrations), or indirect (i.e. mediated by changes in plant chemistry or architecture).

An interesting case of an insect-vectored plant pathogen affecting a non-vector insect is that of the aster yellows mycoplasmalike organism (AY MLO) and Dalbulus maidis. Host plant range of D. maidis is increased after the insect has fed on plants infected with the AY MLO.

In the case of the planthopper Peregrinus maidis, fecundity is increased after the insect has feed on plants infected with the corn stunt spiroplasma, a plant pathogen which the planthopper does not vector.

CIRCULIFER/NEOALITURUS TRANSMISSION OF PLANT PATHOGENS
Meir Klein (Dept. of Entomology, ARO, The Volcani Center, Bet Dagan, Israel)

No one seems to know how many true species there are in the two genera Circulifer Zakhavatkin and Neoaliturus Distant. However, it is agreed among students of the Auchenorrhyncha that certain species, especially among the Circulifer, are highly significant. The beet leafhopper, C. tenellus, is considered the most destructive leafhopper in the USA. It transmits beet curly top virus (BCTV) to numerous agricultural hosts. It also transmits there a mycoplasma, Spiroplasma citri, which causes the stubborn disease in citrus and other crops. These diseases occur also in the Mediterranean region and in the Middle East. Stubborn disease causes great damage to citrus. C. haematoceps is a vector of the BCTV in the Middle East. S. citri is transmitted in the Mediterranean by more than one species of Circulifer: members of the C. tenellus complex and the C. haematoceps complex. Quite probably, additional Circulifer and perhaps Neoaliturus species are involved in the transmission of these two plant pathogens. Apart from these two pathogens, C. tenellus is a vector of mycoplasma like organisms (MLOs) such as the beet leafhopper-transmitted virescens agent in the USA. In the Old World, N. fenestratus trnnsmits an MLO causing safflower phyllody. It is also quite probable that members of these two leafhopper genera are vectors of the MLO causing Vinca phyllody and a comparatively new spiroplasma, S. phoenicum.

Various strains of BCTV were found in the USA. Strains and isolates of S. citri of different action on host plants are known to exist in both the USA and the Mediterranean. The BCTV is a geminivirus and the specificity of such a virus to leafhopper vectors is being investigated. On the other hand, little is known about the specificity of mycoplasmas and MLOs to their vector. It is believed to be governed by principles different from those relevant to viruses.

TRANSMISSION OF RICE TUNGRO VIRUSES BY NEPHOTETTIX. H. Hibino (National Agriculture Research Center, Kannondai, Tsukuba, Ibaraki, 305 Japan)

Tungro disease of rice is the major constraints to stable rice production in irrigated areas in the Asian tropics. The devastating epidemics of tungro have occurred in many countries after the intensification of rice cultivation by introducing improved cultivars in the late 1960s. Tungro is caused by rice tungro bacilliform virus (RTBV) having circular ds-DNA and rice tungro spherical virus (RTSV) having ss-RNA. Both viruses are transmitted in a semi-persistent manner by Nephotettix sps. and Recilia dorsalis. RTSV is transmitted independently, while RTBV requires a RTSV-related "helper" factor for its transmission by leafhoppers. Rice cultivars with resistance to the principal vector N. virescens have been used widely to manage tungro. On resistant cultivars, leafhoppers feed mainly on xylem and gave a low level of seedling infection. On susceptible cultivars, tungro viruliferous leafhoppers generally transmit both viruses togather or RTBV alone, but on resistant cultivars, they predominantly transmit RTBV alone. Many resistant cultivars that had formaly a little tungro have had severe tungro after a few years of intensive cultivation due to the development of N. virescens populations with higher virulence to the resistant cultivars. Scheduled planting to have a definite fallow period between two crops in each area reduces remarkably tungro incidence.

SIMULATION ANALYSIS OF WHITE-BACKED PLANTHOPPER POPULATION DYNAMICS ON FIRST SEASON RICE IN ZHEJIANG PROVINCE, CHINA. Zeng-Rong. ZHU*, J. A. CHENG*, C. W. HUANG#, B. C. FENG# and X. CHEN* (*Department of Plant Protection, Zhejiang Agricultural University, 310029, Hangzhou, China, #Insitute of Plant Protection, Zhejiang Academy of Agricultural Sciences, Hangzhou, China)

A simulation model of white-backed planthopper (WBPH), Sogatella furcifera (Hovarth), population dynamics on first season rice in Zhejiang Province, China, was constructed using field population data together with information from the documents. In this paper the model is described and its predictions compared with independent sets of field data. For nine data sets from 1983 to 1989, representing a 11-fold range of WBPH peak densities, time of the peak in the WBPH population was predicted within 5 days in all nine cases (accuracy of observations 5 days). The peak density of the population was predicted within 20% of the observed in seven cases. Model parameters were varied within realistic limits in order to determine the sensitivity of the model. The model was sensitive to changes in pattern and amount of immigration. Simulation analysis showned that the earlier and the more the major immigration does, the larger the peak density is, and the reverse is true. A very short concentrated period and high level of WBPH immigration shoutd resulted in damaging WBPH population. The comparison of decrepancies between simulated and observed population dynamics indicated that a more suitable method for estimation the distribution of immigrants needed to be developed.

EFFECT OF AGRICULTURAL PRACTICES ON *CICADULINA* LEAFHOPPER DISTRIBUTION AND ECOLOGY IN AFRICA

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Studies on *Cicadulina* leafhopper distribution, biology, and ecology in Africa have been closely related to and stimulated by the role the insect plays in transmitting two major viral diseases: the maize streak virus (MSV) and the maize mottle/chlorotic stunt virus (MM/CSV). The severe epidemics of MSV in the 70s and 80s has initiated a series of regular surveys, collections and experiments on *Cicadulina* in West Africa. Rose's pioneering publications on *Cicadulina* ecology and movements continue to serve as the example of proven methodology and techniques used in studies on *Cicadulina*. Recent severe outbreaks of MSV in Eastern Africa (e.g., in Zambia, Zimbabwe, Mozambique, Kenya, and Burundi) have focused the interest of scientists in national programmes on *Cicadulina* research. Numerous samples of the insect have been sent by these scientists (as well as by university graduate students) to the author for identification.

Based on the available literature and on the author's published and unpublished results, new geographical macro-distribution maps of various species of *Cicadulina* are presented. Their distribution and ecology are closely related to the availability of their preferred host plants — certain grass species whose growth and composition is affected by agricultural practices. Rapid changes in species composition and density at the end of rainy seasons induces mass migrations of leafhoppers across large ecological zones.

Recent changes in agricultural practices from large- to small-scale farming in some countries, development of large irrigation schemes, moving of maize cultivation to new eco-climatic zones and continuous planting of maize are some of the factors in addition to unpredictable weather conditions, affecting *Cicadulina* population composition, biology and ecology, and influencing the development of this pest on host grasses and its later migration to crop plants.

Population Dynamics of Cicadulina leafhopper species in relation to maize streak virus epidemiology. N. A. Bosque-Perez, International Institute of Tropical Agriculture, Ibadan, Nigeria

The epidemiology of maize streak virus (MSV) is closely related to the ecology of its vectors, leafhoppers in the genus Cicadulina. Regular surveys in Nigeria have revealed that during the dry season when grasses are dead or dormant leafhopper population densities are very low (<0.5 leafhoppers/m^2) except in low-lying areas with residual moisture or in irrigation schemes. In the savanna Cicadulina populations increase during the rains, and reach a peak in September (3-9/m^2). In the forest zone, however, Cicadulina populations remain low during the rainy season and peak after the end of the rains (3-5/m^2). C. mbila is the predominant vector species and four other species are less common. Virus transmission tests have revealed that 45-60% of field-collected Cicadulina are potential vectors, but the proportion of viruliferous ones is very low during the early part of the rainy season. This proportion rises as the season progresses and reaches maxima of 15-25% at the end of the growing season. Studies on dispersal of C. storeyi in maize fields have shown wind to be a major factor affecting direction of leafhopper movement, and leafhoppers to prefer young (2-6 week-old) maize. Other studies have demonstrated virus-infected plants to have a clustered pattern, indicating that Cicadulina spread maize streak virus predominantly from plant to plant within a maize field.

TRANSMISSION OF MAIZE STREAK VIRUS BY *CICADULINA* SPECIES. Peter G Markham (Department Virus Research, John Innes Institute, Colney Lane, Norwich, Norfolk, NR47UH, U.K.)

Maize streak virus (MSV) is found throughout Africa, and is transmitted by at least nine species of *Cicadulina*. The most efficient vector is *C.mbila*, however in certain areas other species may play a major role. We have investigated many of the interactions that contribute to the efficiency of *C.mbila*. Characterising many isolates showed that there were three strains (now named viruses) that differed in serotype, symptoms, and physical morphology of viral inclusions within the plants. Host species was important for efficiency of acquisition. Feeding preferences were studied using an AC-electronic monitoring system. *C.mbila* was typically a phloem feeder. *C.mbila* is attracted to severely infected maize due to the yellowing and has a preference for the chlorotic lesions. A change in feeding behaviour on infected maize ensures feeding in mesophyll tissue. This probably accounts for the highly efficient acquisition of MSV from severely infected maize but not from *Digitaria* infected by the same virus.

The virions are specifically absorbed, as crystaline inclusions, in the filter chamber of the vector by receptor-mediated endocytosis. Adults or nymphs of *C.chinai*, although able to transmit MSV efficiently after injection are not able to acquire. Once in the cells the virus uses the endosomal pathway to pass to the plasma membrane and into the haemolymph. The virus is absorbed by particular secretory cells in the salivary glands.

POPULATION ECOLOGY, DISPERSAL, AND PATHOGEN SPREAD BY THE CORN LEAFHOPPER Dalbulus maidis. Alison G. Power (Section of Ecology & Systematics, Corson Hall, Cornell University, Ithaca, New York, U.S.A.)

The corn leafhopper Dalbulus maidis is the primary vector of three stunting pathogens of maize: the corn stunt spiroplasma, the maize bushy stunt mycoplasma, and the maize rayado fino virus. A better understanding of leafhopper ecology and dispersal can provide insight into patterns of disease spread and lead to more effective management programs. Experiments were carried out in Costa Rica and Nicaragua to investigate the population dynamics and movement behavior of D. maidis in different maize cropping systems and planting patterns. Leafhoppers were less abundant and pathogen incidence was lower in maize/bean polycultures than in maize monocultures, apparently because beans inhibited leafhopper movement. Maize planted at higher densities had fewer leafhoppers and lower pathogen incidence. Leafhopper movement behavior and pathogen spread was also influenced by planting pattern, i.e. the distance between rows and the distance between plants within a row. These results suggest that manipulations of planting pattern and cropping system could be effectively used in a pest management program for D. maidis.

FOOD FORAGING BEHAVIOR IN FRUGIVOROUS FRUIT FLIES. Jorge Hendrichs (IAEA Laboratories, Entomology Unit, A-2444, Seibersdorf, Austria), Ronald J. Prokopy (Department of Entomology, University of Massachusetts, Amherst MA 01002, USA.)

Starting with emergence and throughout their lives, adult tephritid fruit flies require daily intake of nutrients for maintenance, reproductive maturity and egg development. Accordingly, they spend daily considerable time and effort foraging for food. Unlike mate and fruit foraging behavior, however, food foraging behavior has not been examined in a systematic way in tephritid fruit flies. This is surprising in view of the widespread use of foodbaited traps and insecticide-food bait sprays imposed against strong environmental opposition. Here we summarize food foraging studies comparing the temperate apple maggot fly Rhagoletis pomonella and the tropical Mediterranean fruit fly, Ceratitis capitata. We proceeded from general questions addressed by systematic observational investigations of these two species in nature to more specific question addressed by experimental manipulation under controlled field cage and laboratory conditions. findings are discussed as to their theoretical significance as well as their direct bearing on strategies and tactics for managing these two major fruit pests.

MOLECULAR GENETIC STUDIES ON THE MEDFLY, CERATITIS CAPITATA. A.S. Robinson, (IMBB, P.O. B. 1527, Heraklion 711 10, Crete, Greece), A. Zacharopoulou (Dept. Biology, Univ. Patras, Patras, Greece) and G. Franz (IAEA Laboratories, Seibersdorf, Austria).

The medfly (C. capitata) has been the target of a concerted molecular genetic investigation in order to achieve genetic transformation in this important agricultural pest. In essence, the approach involves the cloning of genes which can be used as transformation markers and the development of transformation vectors. Progress in both these approaches will be described. The availability of polytene chromosomes in the medfly has been exploited to enable cloned genes to be rapidly assigned to their cytological location and thereby to correlate the genetic and cytological maps. Chromosome V in the medfly has been particularly well mapped. Data will presented to show how polytene chromosomes can be used to improve the design of genetic sexing lines based on male-linked translocations. A major thrust has also been made on the development of molecular markers for population processes involving RFLP's, mitochondrial probes and random amplified polymorphic DNA markers (RAPID's).

ADVANCES IN ATTRACTANT AND TRAPPING TECHNOLOGIES FOR TEPHRITIDS. A.P. Economopoulos (Department of Biology, University of Crete, 711 10 Heraklion, Crete, Greece), G.E. Haniotakis (Institute of Biology, Demokritos N.R.C., 153 10 Ag. Paraskevi Attiki, Greece).

The McPhail glass trap baited with food-odour liquid lure is still in use. In recent years it is also produced in two plastic halves, the lower one often made of yellow colour to add visual attraction. Sex attractant and insecticidal dispenser may be added to increase fly attraction and killing.

Dry traps combining sex lure and insecticidal dispenser are used extensively (Steiner, Nadel type). Insecticides are replaced by sticky surfaces in certain dry traps (Jackson). Colour attractant has been added on some or all the surfaces of the traps.

A wide range of coloured sticky devices (mostly of yellow, red or black colour) which may combine food or sex odours have been developed for various tephritids.

Pheromones and parapheromones have been studied and applied widely. Their potentials are probably not fully utilized yet because the behaviour of flies in response to these chemicals is not completely understood. For some tephritids, the above chemicals have been applied successfully as powerful attractants for monitoring or control purposes.

Genetic sexing systems for the Mediterranean fruit fly Ceratitis capitata (Wied.) : their construction and performance. Gerald Franz and Philippe Kerremans (International Atomic Energy Agency, Joint FAO/IAEA Programme, Seibersdorf Laboratory, Entomology Unit, A-2444 Seibersdorf, Austria)

The Medfly causes enormous damage to fruit in tropical and sub-tropical areas. The use of genetic sexing strains can increase effioiency and substantially reduce the costs associated with eradication or control strategies based on the Sterile Insect Technique (SIT).

We have isolated new genetic sexing strains for the Medfly in order to improve both genetic components of this strategy, i.e. the sexing gene and the linkage of this mutation to the male sex. In these strains a temperature sensitive lethal (tsl) mutation is used for sex separation and stability is improved by using Y-autosome translocations with breakpoints that map close to this mutation. The structure and the performance of these new strains will be discussed in comparison to the existing systems.

MUTANTS, CHROMOSOMERS AND GENETIC MAPS IN THE MEDITERRANEAN FRUIT FLY. Y. Rossler ("Israel Cohen" Inst. Biological Control, CMBI, 27 KKL Str., Rehovot, Israel), A. Malacrida (Univ. di Pavia, Dip. Biologia Animale, Piazza Botta 9-10, I-27100 Pavia, Italy), M.C. Zapater (Cat. de Genetica, Fac. Agron., Univ. de Buenos Aires, 1417 Buenos Aires, Argentina.

The Mediterranean fruit fly has 5 pairs of autosomes and a pair of sex-chromosome. They have been analyzed in the meiotic, mitotic and polytene stages. More than 120 morhpological, biochemical and behavioral loci were isolated and studied since 1973 by 18 laboratories throughout the world. More than 40 loci were assigned to, and mapped on the 5 autosomal pairs, a single marker (red eye) was located on the X-chromosome. Male recombination was found frequent in that species. Chromosomal inversions and translocations were constructed, and some were utilized in Sterile-Male-Release projects (in Italy and Israel) for sex separation of the pupae prior to release. Current research includes construction of "balancer" strains, detailed cytogenetic studies, molecular biology studies, as well as continuation of the work described in this presentation. The practical value of the information accumulated to date, the problems involved in the rapid and accelerated accumulation of genetic knowledge of that species, and the need for world-wide consolidation of information is discussed.

ADVANCES IN MEASURING QUALITY AND ASSURING GOOD FIELD PERFORMANCE IN MASS REARED FRUIT FLIES. C. O. Calkins (USDA-ARS, P.O.Box 14565, Gainesville, FL), T. Teruya (Fruit Flies Laboratory, Okinawa Prefectural Agric. Exp. Sta. 4-222, Sakiyama-Cho, Naha 903 JAPAN), K. Bloem (USDA-APHIS, American Embassy-Guatemala, APO Miami, FL 34024).

Several laboratory tests of fruit fly behavior have been developed to bioassay the effectiveness of the flies in the field after release. Standardized release-recapture procedures were developed. Percent recapture and longevity data correlated well with laboratory tests for flight ability and longevity tests. Male size correlated well with dispersal rates and longevity. Laboratory flies were caught in higher numbers in areas where wild flies had been caught in higher numbers previously, indicating that released flies preferred the habitat most attractive to wild flies. Collections of eggs of melon flies later in the life cycle resulted in flies that lived longer and competed better in the field after release.

NUTRITIONAL AND BIOCHEMICAL ASPECTS OF QUALITY CONTROL IN OLIVE FRUIT FLY. Manoukas, A.G. (Institute of Bioloy, N.R.C. "Demokritos", Athens 153 10, Greece).

A test application of the sterile insect technique, in Greece, failed to control the olive fruit fly, Dacus oleae, Gmel. (Diptera: Tephritidae). This initiated evaluation of the existed data and further research in the artificial rearing system. Determination of certain biological and biochemical parameters of naturally grown (wild) and artificially reared (lab.) insects was made. Such parameters included, among others, egg hatchability, larval growth, developmental time, pupation, adult emergence, amino acids, lipids and minerals. In addition nutritional and other dietary properties were determined in the two types of food (olive fruit mesocarp and artificial diet). Significant differences were found between the two types of insects (wild and lab.) and the two types of food (olive and diet). Critical dietary factors, which may affect quality traits of the olive fruit fly were evaluated. The results will be presented and discussed in connection with the quality control of artificially reared insects and the failure of the sterile insect to suppress the wild population.

MASS REARING OF FRUIT FLIES: A DEMOGRAPHIC ANALYSIS. P. Liedo (Centro de Investigaciones Ecologicas del Sureste, A.P. 36, Tapachula, Chiapas, 30700 Mexico), J.R. Carey (Department of Entomology, University of California, Davis CA 956161, USA), R.I. Vargas (U.S. Department of Agriculture, Tropical Fruit and Vegetable Research Laboratory, P.O. Box 2280, Honolulu, HI 96804, USA).

Population harvesting demographic models have been developed for management of fish, forest, and animal resources. Their purpose is to determine optimal discard age and the fraction of the population that has to be harvested.

A review on the application of these models to fruit fly mass production for SIT (Sterile Insect Technique) will be presented.

Discussion will include implications to current programs, design of future mass rearing facilities, strategies for colonization or adaptation of wild strains to laboratory conditions, flied applications, and resource planning.

THE MOSCAMED PROGRAMME: PRACTICAL ACHIEVEMENTS AND CONTRIBUTION TO SCIENCE. J. Reyes, D. Orózco, W. Enkerlin, A. Perez (2a. Anenida Sur # 5-3, Tapachula, Chiapas. 30700 Mexico)

The Mediterranean fruit fly (*Ceratitis capitata* WIED), entered the southeast of Mexico in 1977. It was considered that the establishment of this pest would cause great economic damages to production of agricultural commodities in Mexico and the United States of America. For this reason, both governments in collaboration with Guatemala created the Moscamed Program to stop and eradicate this pest.

The most important achievement of this program was to eradicate the medifly from Mexico in 1982 and keep the country free of this pest since then.

This achievement has been possible among other things, because of continues on site research and methods development. Contributions to Science and practical application of SIT can be grouped in three main aspects: 1) large scale mass rearing, 2)quality control, and 3) field operation activities.

The technology development and experience accumulated have been the fundamental basis for several fruit fly programs in the world, including the one to control and eradicate four native species of fruit flies in Mexico.

We will describe what we considered the most important developments of the Moscamed Program.

FRUIT FLY PROBLEMS IN CHINA AND PROSPECTS FOR USING THE STERILE INSECT TECHNIQUE. Hua-song Wang, He-qin Zhang (Institute for Application of Atomic Energy, Chinese Academy of Agricultural Sciences. P.O.Box 5109, Beijing 100094, China)

The major species of fruit fly injuring fruits and vegetables, their distribution and economic importance.

About 56000 and 95000 irradiated sterile males of Chinese citrus fly *Dacus citri* (Chen) were released in Zhonglian orange orchard of about 34 hectares in Huishui county, Guizhou province in 1987 and 1989 respectively. The release ratio of sterile to native fruit fly was 12.5 : 1 and 45 : 1 respectively. The rate of damage orange by Chinese citrus fly *Dacus citri* (Chen) dropped from 7.5% in general to 0.005%.

Key words: Male sterile technique, release ratio, Chinese citrus fly

THE MELON FLY ERADICATION PROGRAM IN JAPAN. Hiroyuki Kakinohana (Okinawa Prefectural Fruit Fly Eradication project Office, 123 Maji, Naha 902 Japan)

The melon fly not only causes serious damages to cucurbit crops but also infests various fruits and vegetables. Owing to its occurrence in Southwestern Islands of Japan, transportation of such hosts from the islands has been strictly prohibited by Plant Protection Law. Such a restriction makes it imperative not only to reduce its infestation level, but to eradicate it from the islands.

On Kume Is.(60km^2) an experimental melon fly eradication project was started in 1972 using SIT. Following its successful eradication on Kume Is. in 1978, eradication projects for all Southwestern Isls. have been carried out by Okinawa and Kagoshima Prefecture.

Okinawa program; After the suppression of the wild population by a male annihilation method, sterile flies releases on Miyako (227km^2) and Okinawa(1,379km^2) Isls. were started in 1984 and 1986, respectively. The melon fly on Miyako and Okinawa Isls. was successfully eradicated in 1987 and 1990, respectively. On Yaeyama Isls.(584km^2), the final target area, the eradication program has been carried out from 1989.

Kagishima program; The melon fly eradication program from the Southwestern Isls. of Kagoshima by SIT was begun in 1979, and new facilities were constructed. The melon fly was eradicated on Kikai(57km^2), Amami Oshima(820km^2) and Tokunoshima(248km^2), Okierabu(94km^2) and Yoron(20km^2) islsnds in 1985, 1987 and 1989, respectively.

POPULATION GENETICS OF Ceratitis capitata AND PHYLOGENETIC RELATIONS WITH OTHER TEPHRITIDAE. G. Gasperi, A.R. Malacrida, L. Baruffi, R. Milani (Department of Animal Biology, University of Pavia, I-27100 Pavia, Italy), C.R. Guglielmino (Department of Genetics and Microbiology, University of Pavia, I-27100 Pavia, Italy)

Two ancestral populations (Kenya and Reunion), two ancient (Sardinia and Procida, Mediterranean Basin) and one new population (Guatemala) of C. capitata were examined by electrophoresis for genetic variability at 27 biochemical loci. Two ordination approaches (principal component analysis and a tree representation) and F statistics analysis have been used to distinguish the various patterns of genetic variations and to infer the underline causes and their relative contribution to the total variation. Three main patterns of variation which emerge from the data are related to geographical, annual and seasonal differentiations.

Different approaches of cluster analysis applied to a set of electrophoretic data have provided congruent evidence for phylogenetic relationships among C. capitata and the following species of Tephritidae, namely Ceratitis rosa, Trirhithrum coffeae, Anastrepha suspensa, Capparimyia savastani and Dacus oleae. These electrophoretic analyses have also offered a suitable approach to taxonomy of Tephritidae. Construction of electrophoretic keys for species identification at immature stages has been allowed by detecting electrophoretic differences among the above mentioned species.

THE ROLE OF STERILE MOTH RELEASES IN PINK BOLLWORM MANAGEMENT SYSTEMS. T. J. Henneberry, USDA-ARS-Western Cotton Research Laboratory, 4135 E. Broadway, Phoenix, AZ 85040 (USA).

Pink bollworm, Pectinophora gossypiella (Saunders), sterilized by exposure to 20 krad of gamma radiation, were released on 216 days of a 458-day experimental period in pink bollworm-infested cotton plots. Release rates averaged about 100,000 sterile moths/release day. Reductions of larval infestations in bolls began when ratios of released sterile male to native male moths averaged about 70:1. When releases of sterile moths were terminated, the pink bollworm larvae per boll increased from 1 to 3.7 over a 58-day period. Several sampling techniques revealed that released sterile moths were noncompetitive with native males in obtaining native female partners. However, when ratios of released sterile moths to native insects were high enough to overcome this disadvantage, larval infestations in bolls were reduced. Assuming other management technologies can be effectively integrated into a systematic effort to suppress pink bollworm populations to low numbers and the quality of released sterile insects can be improved, the sterile-release system may be considered a viable component of a total management system in the future, in infested cotton areas. The special application of sterile moth releases to prevent pink bollworm establishment in the uninfested San Joaquin Valley of California has been in practice since 1968. Average sterile to native moth release ratios over more than 200:1 have apparently been effective since no documented infestation occurs at this time.

INFESTATION BY THE MEDITERRANEAN FRUIT FLY (DIPTERA: TEPHRITIDAE) IN THE MAGHREB. E.J. Buyckx,c/o Joint FAO/IAEA Div. of Nuclear Techniques in Food and Agriculture, IAEA, A-1400 Vienna, AUstria

So far, this fruit fly, Ceratitis capitata,is the only one found in North-west Africa or Maghreb (Algeria, Libya, Morocco, Tunisia). These countries requested IAEA assistance in determining the feasibility of eradicating by the SIT the Medfly from the region. An important aspect in estimating resources required for an eradication program is the distribution of the pest. Estimating infested areas has been attempted on an ecoclimatological basis and on host plant occurrence. Under the combined influence of sea, altitude and latitude, seven sub-climates may be identified of which three have a mean annual rainfall below 400 mm- the arid, very arid and desertic- where wild host plants (fruiting over a short period) and cultivated fruit occur only in spots where there is ground water, and hot weather (50°C) and low relative humidity (below 30%) are unfavourable for the Medfly. In the mountains cold winters exclude its survival. In conclusion the Medfly cannot survive in areas with mean annual rainfall below 300 mm (except in some irrigated spots) and/or a monthly mean of minimum temperature during the coldest month of m=or < 3°C. Of a total land area for the Maghreb of 4,758,340 km^2, only about 880,000 km^2 are rainfed agriculture areas with permanent Medfly populations, suitable for using the SIT.

XS-6 USA Quarantine Treatments–International Passports for Agricultural Commodities

THE FOUNDING AND ESTABLISHMENT OF EXOTIC INSECT PEST POPULATIONS. Kenneth Y. Kaneshiro. Hawaiian Evolutionary Biology Program, University of Hawaii, Honolulu, Hawaii 96822.

Sexual selection via female choice is the differential mating success among males, i.e. some males are more successful than others in securing mates. At the same time, some females are highly discriminant while others are not so discriminant in mate choice. A model depicting sexual selection as a truly dynamic system is described and applied to an understanding of how insect pests can invade, colonize and become established in a new environment. Under small population size such as is the situation during early stages of colonization, significant shifts in the distribution of mating types in the population can result in corresponding shifts in gene frequencies and perhaps act to destablize the coadapted genetic system of the population. Novel genetic recombinants that may be preadapted to survive in the new habitat may be produced and strongly selected especially if they are linked to the genome of less discriminant females. It is essential to understand the basic biologies, especially that of the mating system, in order to understand the dynamics of insect populations and to be able to develop effective control and management programs without the excessive application of chemical pesticides. These ideas are applied to the "frequent" medfly infestations in California.

QUARANTINE TREATMENTS TO CONTROL INSECTS OF REGULATORY IMPORTANCE IN COMMODITIES EXPORTED FROM THE WESTERN U.S. TO PACIFIC RIM COUNTRIES. Victoria Y. Yokoyama and Gina T. Miller. U.S. Dep. Agric., Agric. Res. Ser., Hort. Crops Res. Lab., 2021 S. Peach Ave., Fresno, CA 93727, USA.

Compression (42-80 kg/cm^2) and hydrogen phosphide fumigation (60 g/28.3 m^3 for 7 d > 5°C) were developed as quarantine treatments to control Hessian fly, Mayetiola destructor (Say), in compressed hay for export to Japan; a pest-free period between the beginning of stone fruit harvest and July 1, a methyl bromide fumigation (40 g/m^3 for 2 h at ≥ 21°C), and the non-host status of plums were developed as quarantine strategies to control walnut husk fly, Rhagoletis completa Cresson, in stone fruits for export to New Zealand; a methyl bromide fumigation (48 g/m^3 for 2 h at ≥ 21°C), was developed to control codling moth, Cydia pomonella (Linnaeus) in nectarines packed in bins and shipping containers for export to Japan; a high temperature treatment of 45°C for 55 min and a methyl bromide fumigation of 32 g/m^3 was found efficacious to control oriental fruit moth, Grapholita molesta (Busck), in stone fruits for export to British Columbia; and a low temperature treatment and methyl bromide fumigation is under developement to control omnivorous leafroller, Platynota stultana Walsingham, in table grapes for export to Australia. Temperature extremes, pressure, and insect-plant interactions have been extensively studied as alternatives to chemical fumigants to control these pests.

HEAT TREATMENTS OF MANGOES AND CITRUS FOR MEXICAN ANASTREPHA SPECIES. Mangan, Robert L. (U. S. Dept. Agric., Agric. Res. Serv., 2301 S. Inter. Blvd., Weslaco, Texas 78596, USA)

Mango and citrus producing regions of Mexico and Central America are infested by the West Indian fruit fly, (Anastrepha obliqua Macq.) an important pest of mangoes and the Mexican fruit fly (A. ludens Loew) which attacks mangoes, grapefruit, oranges and tangerines. Hot air, with controlled humidity, can be used to raise the temperature of the fruit to kill larvae of these pests without degrading the fruit quality. The treatment times and temperatures depend on the physiology and size of the fruit and the tolerance of the insect. Probit regressions that relate mortality to treatment temperatures or time have large errors and are poor models for predicting mortality levels sufficient for quarantine security. Maximum fruit tolerance for temperatures and experimental determination of larval mortality temperatures have provided more precise estimates of treatment parameters. Quarantine security is then confirmed by killing >100,000 larvae in infested fruit.

USA QUARANTINE TREATMENTS -- INTERNATIONAL PASSPORTS FOR AGRICULTURAL COMMODITIES. *Jennifer L. Sharp* (USDA/ARS, SAA, Subtropical Horticulture Research Station, 13601 Old Cutler Road, Miami, FL 33158, USA)

Major quarantine pests of fruits and vegetables of states in the Southeast USA include the banana moth, *Opogona sacchari* (Bojer) (Lepidoptera: Tineidae); sweet potato weevil, *Cylas formicarius elegantulus* (Summers) (Coleoptera: Apionidae); Fuller's rose weevil, *Pantomorus cervinus* (Boheman) (Coleoptera: Curculionidae); Caribbean fruit fly, *Anastrepha suspensa* (Loew) (Diptera: Tephritidae); papaya fruit fly, *Toxotrypana curvicauda* Gerstaecker (Diptera: Tephritidae) and the melon thrips, *Thrips palmi* Karny (Thysanoptera: Thripidae). Many states and importing countries do not have these pests and have established quarantines to prevent their introductions. The pests and economic importance of the need to restrict their movements are discussed.

PREHARVEST PEST MANAGEMENT AND POSTHARVEST INSECTICIDAL DIP AS A SYSTEMS APPROACH TO QUARANTINE TREATMENT FOR TROPICAL CUT FLOWERS. Arnold H. Hara, Trent Y. Hata, Lei S. Imaino, Benjamin K.S. Hu and Victoria L. Tenbrink (University of Hawaii, 461 West Lanikaula Street, Hilo, Hawaii 96720 USA).

A systems approach consisting of preharvest insecticide application, field sanitation and a postharvest insecticidal dip provided quarantine security eliminating all insect pests of the tropical cut flower, red ginger, Alpinia purpurata (Vieill.) K. Schum. including banana aphids, Pentalonia nigronervosa Coquerel, cotton aphids, Aphis gossypii Glover, citrus mealybugs, Planococcus citri (Risso), obscure mealybugs, Pseudococcus affinis (Maskell), long-tailed mealybugs, Pseudococcus longispinus (Targioni-Tozzetti), cardamom thrips, Sciothrips cardamomi (Ramakr), earwigs, Chelisoches morio (Fabricius) and ants, Technomyrmex albipes (Fr. Smith). Preharvest insecticide application consisted of chlorpyrifos 50 DF applied to the foliage at 2-week interval, or chlorpyrifos 20 MEC applied as a insecticide barrier treatment. Field sanitation involved harvesting all mature flowers at weekly intervals. A postharvest dip combination of fluvalinate 2.0 F and insecticidal soap (potassium salts of fatty acids) for 5 minutes with agitation provided quarantine security. The above procedure plus a final inspection of flowers for insects assured pest-free ginger flowers that met quarantine requirements.

POSTHARVEST TREATMENTS OF TROPICAL CUT FLOWERS AND FOLIAGE. James D. Hansen, USDA, ARS, Subtropical Horticulture Research Station, Miami, Florida 33158 USA

Quarantine regulations prevent the importation of tropical cut flowers and foliage carrying living insects. The pests most frequently encountered are homopterans. Recent research is presented which exemplifies progress in developing methods for disinfesting these insects from floral materials before shipment. Advantages and drawbacks of fumigation, chemical dips, heat treatments, and other methods are discussed. An effective treatment eliminates the pest without injuring the floral commodity. Because of the delicate nature of certain flowers, some treatments are more suitable than others.

AN OVERVIEW OF QUARANTINE TREATMENT TECHNOLOGIES FOR AGRICULTURAL COMMODITIES. Jhon W. Armstrong (UADA-ARS-PWA, Tropical Fruit and Vegetable Research Laboratory, P.O. Box 4495, Hilo, Hawaii 96720 USA)

After the development of methyl bromide and ethylene dibromide, fumigation became the primary method for disinfesting fresh fruit of tephritid fruit flies. The inexpensive and easily used fumigation technology replaced both the use of and research into physical or other non-chemical disinfestation strategies until the 1980's. Public concern over health issues led to increased restrictions on the use of toxic pesticides, especially when used on foods. Many pesticides have been banned in the United States and other countries, including the use of ethylene dibromide as a postharvest quarantine fumigant. The only remainig postharvest fumigant of major importance for fresh fruit is methyl bromide and, until on-going scientific evaluations comfirm its historical safety record, the long-term retention of this fumigant as a quarantine treatment is questionable. Therefore, alternative treatment technologies must be developed to replace fumigation. Discussed here is an overview of quarantine treatment technologies now available, and areas where research and development is needed.

Postharvest Insect Disinfestation Heat Treatments and Fruit Ripening
Robert E. Paull
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The loss of ethylene dibromide as a fumigant has meant that alternative physical disinfestation procedures, especially heat treatment are actively been developed. The current forced hot air treatment requires that the fruit core temperature should reach 47.2°C and is a variant of the old vapour heat treatment. Vapor heat disinfestation is currently the only heat treatment approved for papaya, mangoes and other fresh tropical commodities destined for the Japanese market.

Heat treatments for insect disinfestation or to control disease can disrupt fruit ripening. Fruit softening and ethylene production are the most commonly measured disrupted components of fruit ripening. The fruit softening enzymes are sometimes not produced following heating, while the other processes associated with ripening are not apparently influenced to the same extent or soon recover. The sensitivity is modified by differences in response between seasonal, cultivar and rate of heating. The sensitivity can be related to the heat shock response and the presence of heat shock proteins.

THE ROLE OF APHIS IN THE DEVELOPMENT OF QUARANTINE TREATMENTS. Robert R. Hashimoto (United States Department of Agriculture, Animal and Plant Health Inspection Service, International Services, American Embassy, 10-5, Akasaka 1-chome, Minato-ku, Tokyo 107, Japan)

Although all quarantine treatments of commodities for consumption are basically developed by ARS (Agricultural Research Service), the process to achieve acceptance of the treatment program by the importing country and subsequent enforcement of the phytosanitary and certification processes related to treatments are handled by APHIS (Animal and Plant Health Inspection Service). Similarly, the quarantine treatments for commodities intended for consumption in the U.S. are reviewed and recommended by ARS, but the administration and supervision of the treatments are carried out by APHIS. The paper will discuss quarantine treatments relative to APHIS role, covering implementation, correction, completion, and review of the treatment programs.

COMMODITY CONDITION AND QUALITY CONSIDERATIONS OF QUARANTINE TREATMENTS. Roy E. McDonald, William R. Miller (USDA, ARS, 2120 Camden Road, Orlando, FL 32803, USA)

Horticultural commodities can be damaged when they are subjected to some quarantine treatments required for disinfestation purposes. Quarantine treatments must be efficacious but not adversely affect the commodity's quality, condition, and susceptibility to decay. If the quarantine treatment reduces the value of the commodity, then the treatment is not fully effective. Damage manifests itself as the loss of market quality attributes including shelf life, appearance, flavor, texture, aroma, and increased susceptibility to decay organisms. A number of postharvest treatments have been studied for the purpose of insect disinfestation of fresh fruits and vegetables. The effects of disinfestation treatments on market quality of horticultural commodities are reviewed.

XS-7 Bionomics of Economically Important Dacinae (Diptera: Tephritidae)

Classification and Systematics of Dacinae
D.L. Hancock and R.A.I. Drew (Entomology Branch, Qld. Dept. of Primary Industries, 80 Meiers Road, Indooroopilly, Brisbane 4068 Australia.)

The relationship between the Dacinae and other subfamilies of Tephritidae, particularly the Ceratitinae, is noted. The generic classification is discussed, with particular emphasis on the limits of the genera Dacus and Bactrocera. Current problems with the present subgeneric classification are noted and work towards a new classification outlined. The complexities of the Bactrocera dorsalis group are discussed, with particular emphasis on the five most important economic species in SE Asia.

FEEDING PHYSIOLOGY OF DACINAE. Manoukas, A.G. (Institute of Biology, N.R.C. "Demokritos", Athens 153 10, Greece)

Dacinae species have a complex feeding physiology. They are well known for their association with host plants and symbiotic microorganisms. Members of these species respond to nutritional constituents, non-nutritional chemicals and to other properties of food or substrates. The feeding responses are under the influence of olfactory and gustatory stimuli. Immature stages develop in many species of fruit and vegetable crops. They are monophagous or stenophagous but certain species are polyphagous. A few species of Dacinae are very serious pests in many parts of the world. A major difficulty in understanding ecology of these species and in developing successful management strategies is lack of sufficient knowledge of their quantitative nutritional requirements and of feeding mechanisms. This presentation gives the present status of feeds and feeding of several economically important species of Dacinae in nature and in laboratory. The findings are discussed in relation to feeding behavior, host selection, survival, reproduction and management strategies of Dacinae. Emphasis is given to the olive fruit fly, Dacus oleae Gmel. (Diptera: Tephritidae) found mainly in the Mediterranean region. The larval stages of this insect is monophagous in nature. It grows only in the olive fruit.Certain feeds, nutrients, and non-nutritional chemicals, that are affecting survival, growth and reproduction of this insect, are reviewed. Food habitat, location, finding, accepting and suitability is given and discussed.

GENETICS OF THE GENUS *BACTROCERA*
Stephen H. Saul and Susan D. McCombs (Department of Entomology, University of Hawaii, Honolulu, Hawaii 96822, USA)

A comprehensive review of morphological, biochemical, molecular, cytological and behavioral genetic knowledge of the genus *Bactrocera*. The genetic information is discussed as it relates to basic biology of these species as well as relevance to applied programs of population control.

MATING SYSTEMS OF THE DACINES. T.E.Shelly, (Hawaiian Evolutionary Biology Program, Univ. of Hawaii, 96822, USA)

The Prokopy-Burk model predicts that host use patterns of ovipositing females may be an important factor shaping tephritid mating systems . In monophagous species males are expected to establish territories at the oviposition site . In polyphagous species males would be unable to control access to oviposition sites, resulting in the evolution of non- resource based mating systems,such as leks.Field data on the mating behavior of *Bactrocera* species are scant but indicate that,consistent with expectations, these polyphagous species display lek behavior. Male aggregations have been reported for B. tryoni, *B. cucurbitae,* and *B.dorsalis*. In this apper, I describe recent observations on lek behavior in *B.dorsalis* in Hawaii. Males were found to defend individual leaves in an orange tree. Wing-fanning occurred only at dusk and was bimodally distributed among males: some males fanned continuously and others not at all. Calling males also changed perches frequently, while inactive males remained on the same leaf for long periods. Aggressive interactions were brief, and no resident advantage was detected. These observations are compared with data for other *Bactrocera* species and with data for other tephritids.

ECOLOGY OF *BACTROCERA*
Nicanor J. Liquido (United States Department of Agriculture, Agricultural Research Service, Hilo, Hawaii 96720 USA)

The genus *Bactrocera* includes many economically important species that are currently being targeted for area-wide suppression or eradication programs. Success of these programs requires excellent understanding of the population ecology of this very diverse group. I will review the demography, movement, competition, determinants of abundance and distribution, and life history strategies of the genus *Bactrocera*.

THE SIGNIFICANCE OF BACTERIA IN THE BIOLOGY AND ECOLOGY OF BACTROCERA TRYONI. Annice Lloyd, Richard Drew & David Hancock. (Department of Primary Industries, Entomology Branch, 80 Meiers Road, Indooroopilly, Brisbane 4068, Australia)

The first studies of bacteria associated with Dacinae were with the olive fly, *Bactrocera oleae* in 1910. These bacteria were considered to be symbionts essential for the survival of the fly. For many decades following this, any bacteria consistently associated with any species of tephritid fruit fly were also considered to be symbionts, although rigorous proof of mutualistic associations was often lacking. More recently, extensive studies on the bacteria associated with *Bactrocera tryoni* and its host trees have demonstrated a constant and complex interaction, but a symbiotic relationship is unlikely. Certain species of bacteria in the family *Enterobacteriaceae* occur naturally as commensals in the alimentary tract of fruit flies, they colonise the alimentary tract after ingestion, they are introduced into the host tree microflora, they provide nutrients, in particular protein, for egg production and they produce odours which are highly attractive to adult flies and most likely play a role in host detection.

REGULATION OF DACINE PESTS BY PARASITOIDS IN HAWAII. Russell H. Messing (University of Hawaii, Dept. of Entomology, 7370 Kuamoo Rd., Kapaa, Hawaii, USA 97646), Mary Purcell (USDA-ARS Tropical Fruit and Vegetable Research Laboratory, Kapaa, Hawaii, USA 97646)

Three species of dacine tephritid fruit flies *(B. cucurbitae, B. dorsalis,* and *D. latifrons)* cause severe economic damage to fruits and vegetables in Hawaii, both as direct and as quarantine pests. Many parasitic Hymenopteran species have been imported from the Old World tropics to control these species. At present, *B. cucurbitae*and *B. dorsalis* are under substantial biological control by *P.fletcheri* and *B. arisanus*, respectively.

Ecological factors such as phenology, inter- and intraspecific competition, rate of development, and host-habitat finding are shown to play an important role in parasitoid guild dynamics. These factors interact with physiological criteria of host suitability to determine the distribution, abundance, and regulatory potential of each natural enemy species By mapping these ecological parameters in time and space it is possible to identify areas where improvements in biological control are possible. The potential to enhance fruit fly regulation by renewed efforts at classical biological control as well as by augmentation of existing parasitoid populations is discussed.

REPRODUCTIVE THRESHOLD AND POPULATION DYNAMICS OF *BACTROCERA DORSALIS* HENDEL. Charles C.C. Cheng (Department of Biology, Medical College, Kaohsiung, Taiwan 807, China)

The relationship between individual resource use and fitness is of crucial importance to an understanding of population dynamics. Although considerable researches have been conducted for the analysis of the population dynamics of the Oriental fruit fly, *Bactrocera dorsalis* Hendel in the field and laboratory, most of them were based on descriptive models. In the laboratory, the reproductive threshold of the Oriental fruit fly, i.e. a minimum size, expressed in terms of resource use, required for reproduction of the fly, has been studied. The result has shown that there is a significant threshold for reproduction which might be the fundamental reason for its population dynamic behaviour.

POPULATION DYNAMIC OF THE MELON FLY, Dacus cucurbitae Coq. IN THE ILAN AREA, TAIWAN. Lena Wen-Yung Lee, Charles Chien-Chung Cheng (Institute of Zoology, Academia Sinica, Taipei, Taiwan,China)

The study was carried on from July 1, 1989 to the end of September, 1991. Honeydew melon, cantaloupe, musk melon and water melon, also some of bitter melon were grown on the coastal plain of the pacific ocean. Sponge and bottle gourds were planted on the plain areas of the country side. The growing seasons of those vegetables are usually between February and September every year.

The survey of the population for the melon fly, Dacus cucurbitae was conducted from the special plantation area mentioned above by the Formosan Lantern traps with attractant cuelure and 5% insecticide Dibron .The highest population of these flies occurred in August and lowest during December to June of next year. The relationships of the population fluctuation of these flies and the climate, and the fruit losses are discussed.

DESCRIPTION AND LINKAGE ANALYSIS OF GENETIC MARKERS IN THE ORIENTAL FRUIT FLY, *Bactrocera dorsalis* (HENDEL). Susan D. McCombs and Stephen H. Saul, (Department of Entomology, University of Hawaii, Honolulu, Hawaii, 96822 USA.)

The oriental fruit fly, *Bactrocera dorsalis* (Hendel), is an important agricultural pest in the Pacific Basin and a constant threat to the United States Mainland. The extensive economic damage caused by this polyphagous species has been the impetus for research directed towards developing effective non-toxic control measures. The described genetic markers provide tools for understanding basic biological processes and for development of field management practices to enhance the non-toxic sterile insect release method.

The library of genetic markers was constructed by isolating variants in chemical mutagenesis trials and by screening of laboratory colonies and geographic populations from around the state of Hawaii. This genetic library includes 24 markers, 20 of which have been mapped to the 5 autosomal linkage groups. Four types of visible markers are described, 1) eye color: cherry, copper, Grape, gold-grey, mandarin red, yellow eye, and white eye; 2) eye structure: amethyst, Blue, furrow, matte, and notched eye; 3) puparium morphology: elongate puparium, melanistic, robust puparium, and white puparium; and 4) wing morphology: crossveinless, curled, notched, and small.

THE MANAGEMENT OF DACUS DORSALIS HENDEL POPULATION IN TAIWAN
Yu-Chang Liu (Department of Entomology, National Chung Hsing University, Taichung, Taiwan, China)

The oriental fruit fly distributes throughout the whole island of Taiwan,however, the high population always appeared in the south part, especially in Pingtung, Kaohsiung and Taitung.The fly occurred throughout the year and the population reached to the highest peak usually from June to August.The highest population was found to be closely related to the ripening seasons of the fruits, the temperature and rainfall.The field fly population was under controlled by male annihilation control program, however, both the fly population and the fruit damages were happened to increase at the end of fruit harest season and in the unmanaged orchards.For managing the oriental fruit fly, the sterile-insect technique, the male annihilation technique, the integrated control, the food attraction, the paper bagging and occasionally the chemicals had been/is undertaken in Taiwan.The male annihilation project was performed since 1984. The poisoned methyleugenol used with Chung Hsing trap and the fiberboard block were adopted.Four traps and sixteen bottles of methyleugenol for per hectare of orchard are supplied by the government by free. A control line is designed to kill the flies that hidden and moving in the woods along the mountain sides by dropping the poisoned fiberboard blocks from the air by helicopter.The food attractants are developed and improved.

BIONOMICS OF BACTROCERA (DACUS) DORSALIS COMPLEX IN MALAYSIA. Rohani Ibrahim and Abdul Ghani Ibrahim (Department of Plant Protection, Fakulti Pertanian, Universiti Pertanian Malaysia, Serdang , Selangor.)

Several species of fruit flies of economic importance occured in Malaysia. The oriental fruit fly, Dacus dorsalis Hendel does not appear to be present in Peninsular Malaysia, but the dorsalis complex comprises of two species currently known as Malaysia A and Malaysia B. Both species are the pest of commercially grown fruits, with Malaysia A being more prominent than the other with a ratio of 7:1 for Malaysia A to Malaysia B for carambola orchards. The population ratio for the two species varies with different orchards. At least four species of Opiine parasitoids were observed associated with this pest complex, with a mean parasitism of 36.96% in carambola orchard. The duration of the life history of the two species was 22.8 and 22.3 days, with the percentage survival of 71% and 51% respectively.

XS-7 Bionomics of Economically Important Dacinae (Diptera: Tephritidae)

Population dynamics of male Bacterocera dorsalis complex in relation to host phenology and weather in Penang Island, Malaysia.

Muney Serit and Keng-Hong Tan,
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The most important component of the environment affecting male population of B. dorsalis complex in Penang, is availability of suitable hostfruits. In two villages studied - each with more than ten species of fruit trees, starfruit (Averrhoa carambola) contributed significantly to host abundance. High estimated male populations and new recruits were detected three to five and two to four weeks, respectively, after increased in abundancae of starfruits. When population was high, young starfruits (normally not infested) were also oviposited by females. Quantitative values of rainfall, temperature and relative humidity showed no correlation with estimated population parameters or host abundance of the fruit fly. However, estimated male population was generally high during wet seasons and low during dry seasons.

RELATIONSHIP BETWEEN FEMALE SIZE AND DEMOGRAPHIC PARAMETERS IN BACTROCERA MALAYSIAN A (DIPTERA: TEPHRITIDAE). Tock-Hing Chua (Department of Zoology, Universiti Malaya, 59100 Kuala Lumpur, MALAYSIA)

The effect of body size, as measured by the head width, of the female Bactrocera sp. Malaysian A kept separately in sexual pairs (n=10) on the demographic parameters was investigated in the laboratory under ambient conditions of 28-30°C, 78-85 % RH and natural photoperiod. Body size was shown to influence significantly all the demographic parameters. Females of head width 1.6, 1.8, 1.9, 2.0 and 2.1 mm were used, and the mean number of eggs laid per female in its life time was respectively for the different body size: 86.4±48.7, 181.8±56.1, 229.7±72.6, 364.3±69.4 and 477.5±109.3 which was significantly different from one another ($F=3.73$, $p<0.05$) especially the two smaller sizes from the two larger sizes. The regression line for total eggs laid (Y) against head width (X) was $Y = 785.2 X - 1208.7$ ($R^2=0.35$, $p<0.001$). The net reproductive rate (R_o) was respectively 46.5, 123.4, 190.6, 428.5 and 478.8 eggs, while the intrinsic rate of increase (r) was respectively 0.0634, 0.0786, 0.1044, 0.1069 and 0.1087. The survivorship of the females at eclosion was respectively 28.2, 33.5, 27.3, 37.9 and 43.0 days. The results suggest that for mass rearing purpose, larger females which produce more offspring are to be preferred.

BIOLOGY AND ECOLOGY OF AN INTRODUCED POPULATION OF *BACTROCERA LATIFRONS* (HENDEL)
Nicanor J. Liquido and Ernest J. Harris (United States Department of Agriculture, Agricultural Research Service, Hilo, Hawaii 96720 USA)

The Malaysian fruit fly, *Bactrocera latifrons* (Hendel), was discovered in Honolulu, Hawaii in March, 1983. It is now widely distributed in all of the major islands of Hawaii. *B. latifrons* is important in the agriculture of the southern-situated states of the mainland United States because of the possibility of its introduction from Hawaii. We are currently conducting laboratory and field studies with concentration on the life history, host plants, distribution, abundance, movement, and responses to semiochemicals. We will summarize our results and review pertinent literature.

BIONOMICS OF DACUS OLEAE (GMEL.). George E. Haniotakis (Institute of Biology, N.R.C. "Demokritos", P.O. Box 60228, 15310 Ag. Paraskevi, Attiki, Greece).

Dacus oleae, the olive fruit fly, is a major pest of olives in the Mediterranean region, where over 95% of the world's olive oil and table olives are produced. The economic importance of both the host and pest have stimulated extensive studies, which have resulted in an impressive volume of information on pest's life. Female flies use their pointed ovipositors to insert eggs in the olive fruit. Used fruit is marked so that repeated oviposition may be avoided. Maggots feed on the olive flesh, inflicting both quantitative and qualitative damage. Pupation takes place inside the green fruit during the summer and in the soil during the fall. The insect overwinters as pupae in the ground, but in places with mild winters all stages can be found throughout the year. A number of natural enemies as well as extreme environmental conditions restrict excessive increase of wild populations. Of particular interest is are the chemical communication systems which regulate the behaviors of important life processes such as feeding, host detection, oviposition, pupation, and mating. A number of the semiochemicals involved in these systems have been identified and used for monitoring and control of wild populations.

SYNOPSIS OF SUCCESSFUL ERADICATION OF ESTABLISHED FRUIT FLY POPULATION : EXAMPLES FROM JAPAN.
Hiroyuki Kakinohana (Okinawa Prefectural Fruit Fly Eradication Project Office, 123 Maji, Naha, 902 Japan)

The oriental fruit fly was discovered early in this century on the Southwestern and Bonin Islsnds, Japan. The fly did serious damage to the production of fruits and vegetables in these area. Transportation of host plants from these area was banned by the Plant Protection Law in order to prevent the spreads of the insect over to mainlands of Japan. Such quarantine measures incurred a great economic hardship on local farmers. On the Southwestern Isls., an eradication program of the oriental fruit fly by using a male annihilation method was begun in 1968. The fly was successfully eradicated from Amami, Okinawa, Miyako and Yaeyama Isls. in 1980, 1982, 1984 and 1985, respectively. On Bonin Isls., the eradication program by using a male annihilation method was started in 1975. However, it was suspected that a less sensitive strain to methyl-eugenol was present. Then the Government decided to adopt the SIT after suppression of the wild population. The SIT was begun in 1978, and the eradication of the fly was achieved in 1984.

The melon fly was first discovered in Yaeyama Isls. in 1919, and 10 years later, it was found in Miyako Isls.. In 1970, it was found on Kume Is., and spread to all Southwestern Isls. in 1974. On Kume Is., an experimental melon fly eradication program was started in 1972 using SIT. Following the successful eradication on Kume Is., eradication program for all Southwestern Isls. have been carried out by Okinawa and Kagoshima Prefecture.

LARVAL FEEDING HABITS OF TWO MOTH SPECIES ATTACKING CYNIPID GALLS. Yoshihisa Abe, Takuya Sanari (Laboratory of Entomology, Faculty of Agriculture, Kyoto Prefectural University, Shimogamo, Kyoto 606, Japan)

Unisexual galls of Trichagalma serratae (Ashmead) (Hymenoptera: Cynipidae) are produced on branches of Quercus acutissima Carruth. Larvae of Andrioplecta pulverula (Meyrick) (Lepidoptera: Tortricidae) and Characoma ruficirra (Hampson) (Lepidoptera: Noctuidae) bore into the galls, and feed on the gall tissue and larvae of the gall wasp under natural conditions. Larval feeding habits of the two moth species were examined in a series of laboratory experiments.

STUDIES ON A CECIDOMYIID SUCCESSOR INHABITING EMPTY MIDGE GALLS. Junichi Yukawa and Shigekazu Haitsuka (Laboratory of Plant Protection, Faculty of Agriculture, Kagoshima University, Kagoshima-shi, Japan 890)

Lasioptera sp. is a cecidomyiid successor and distributed in south-western parts of Japan. This species is univoltine, and the mature larvae overwinter on the ground. The adults emerge from early April to early May, synchronizing with the emergence season of two gall-making species, Pseudasphondylia neolitseae and Daphnephila machilicola which produce leaf galls on evergreen trees of the family Lauraceae. The females of Lasioptera sp. lay their eggs in the empty galls from which the gall makers or their parasitoids emerged. After hatching, the successor larvae live inside the empty galls for about three weeks, feeding on mycelia of a fungus, Pestalotia sp. and leave the galls to drop to the ground. The percentage of empty galls utilized by the successor varied largely from year to year. The population density of this species is related to the number of galls produced by the gall-making species.

Taxonomic status of a gall midge attacking terminal leaf buds of Salix viminalis.

Edvard Sylvén[1] & Linnéa Lövgren[2]
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Plantations of Salix viminalis have recently been established in Sweden for biomass production. In 1988 extensive damage to terminal leaf buds and subsequent side shoot development was observed and the frequency of damage has continued to be high. The cause of the damage is a gall midge, Dasineura sp.n., closely resembling three other species, D. terminalis (H. Loew) producing galls on Salix alba and S. fragilis, D. iteobia (Kieffer) producing galls on S. caprea, and a species reared by Stelter as an inquiline from the galls of D. rosaria on S. repens and described by him under the name of Rabdophaga schreiteri. Morphometric studies revealed that the three first-mentioned of the above four species can be readily distinguished on the basis of the relative length of the ovipositor. So far, no clear structural difference has been found between D. sp.n. from S. viminalis, and the species from S. repens described by Stelter. However, the results of experiments dealing with the host plant relationships give evidence that these two midges are not conspecific. In oviposition preference trials, which included host plants of the four gall midges, D. sp.n. laid most of its eggs on S. viminalis. In performance trials, galls and pupae/adults of D. sp.n. did only develop on S. viminalis. The other three gall midge species laid no or very few eggs on S. viminalis, and no larvae survived.

OVIPOSITION CHOICE AND LARVAL SURVIVAL OF *DASINEURA MARGINEMTORQUENS* (DIPTERA: CECIDOMYIIDAE) ON RESISTANT AND SUSCEPTIBLE *SALIX VIMINALIS*. Stig Larsson, Carolyn Glynn (Dept. Plant and Forest Protection, Swedish Univ. Agric. Sci., Box 7044, S-750 07 Uppsala, Sweden), Donald R. Strong (Bodega Marine Lab., University of California, USA).

Substantial genetic variation exists in *Salix viminalis* resistance to the gall midge *Dasineura marginemtorquens*. Willow clones are stable in their resistance between midge generations and different nutrient levels in both field and laboratory culture. Resistance is manifested as a great difference in larval survival; more than 90% of the larvae die within six days after oviposition on resistant plants while most of the larvae are still alive on susceptible plants. Female midges do not seem to discriminate among willow types. In choice experiments, midges laid many eggs on resistant clones; in about one third of the replicates more eggs were laid on the resistant clone. The plant traits causing resistance are enigmatic. Larval behaviour suggests that resistant plants interfere with feeding behaviour. On resistant plants, most larvae wander for more than 24 hours without initiating any galls before dying. On susceptible plants many first instar larvae begin feeding and initiate galls within this period.

ISLAND BIOGEOGRAPHY AND ECOLOGY OF TROPICAL GALLERS. Fernandes, G.W. & A.C.F. Lara (Departamento de Biologia Geral, CP 2486, ICB/Universidade Federal de Minas Gerais, 30161 Belo Horizonte MG - BRAZIL.

We studied five variables that influence the distribution of the major taxa of the Indonesian gall-forming insects: island size, altitude, plant family size, taxonomic isolation, and plant family age. Galling species richness was significantly influenced by the size of the islands, altitude, and plant family size. Species richness increased with increasing island size, with decreasing elevation, and with increasing plant family size. Clearly, area available for colonization is higher at low altitudes compared to high altitudes. Thus, area must be an important factor influencing galling species richness for the Indonesian Islands. The patterns in galling species richness were strongly influenced by the cecidomyiids, thrips, and psyllids.

PATTERNS IN THE DISTRIBUTION OF GALL-FORMING INSECTS: PROCESSES AND MECHANISMS. Lara, A.C.F. & G.W. Fernandes (Departamento de Biologia Geral, CP 2486, ICB/Universidade Federal de Minas Gerais, 30161 Belo Horizonte MG - BRAZIL)

Gall-forming insect species richness on herbs, shrubs, and trees was studied along xeric and mesic altitudinal gradients in southeastern Brazil. Richness increased with decreasing elevation in xeric habitats whereas no pattern was observed in mesic habitats. Gall formers were significantly more species rich in xeric habitats compared to mesic habitats. Free-feeding insect herbivores were, however, more numerous in mesic habitats. The mechanism producing the pattern in gall richness is the differential mortality in xeric and mesic habitats. Gallers may suffer from higher rates of parasitism, diseases, and plant resistance in mesic habitats compared to xeric habitats. Gallers speciated and radiated in xeric habitats despite the harsher environmental conditions found in there.

DAMAGE OF THE WHITE CABBAGE BY THE APHID BREVICROYNE BRASSICAE IN RELATION TO APHID DENSITY, PLANT GROWTH STAGE AND LEAF POSITION. Liu Shu-sheng(Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China), M. Hommes, R. Hildenhagen (Biologische Bundesanstalt, Institut fur Pflanzenschutz in Gartenbau, Messeweg 11/12, 3300 Braunschweig, Germary)

The response of white cabbage to feeding by the aphid Brevicroyne brassicae was studied in relation to aphid density, plant growth stage and plant leaf position in a glasshouse experiment. Both the head fresh and dry weights of the plants were unaffected by the aphid up to the infestation levels where most of the unfolded leaves and 1-2 head leaves were deformed and the shoot weight and leaf area were significantly reduced by the aphid. Earlier infestations during the plant growth resulted in more adverse effect on the heading of the plant than infestations later. Leaf position did not seem to express much effect. As a whole, this experiment shows clearly that the test cultivar has a large potential to compensate for the effect of aphid feeding in terms of head weight and size. It is suggested that leaf deformation, but not head weight and size, is the critical criterion of concern when determining the control tactics in this aphid-plant system if similar compensation happens in the field.

EPIDEMICS AND DAMAGE EFFECTS OF CEREAL APHIDS IN POLAND AND FORECASTING SYSTEM. R. Leski (Institute of Plant Protection, Poznan 60 318, Poland).

In Poland *Sitobion avenae* (F.) and *Rhopalosiphum padi* (L.) are economically important but sporadic pests. Outbreaks were observed only on 10-15% fields during the period 1981-90. Thus, prophylactic control would result in 85-90% unnecessary treatments.

Aphid feeding on lower leaves did not effect barley and wheat yield while feeding on flag leaf and ear reduced the yields by 12.5-25% and the total protein content in the grain by about 10%. The economic thresholds of 5-10 aphids per tiller at the beginning of flowering seem to be justified.

Any long term prediction of aphid population development have not appeared reliable due to often observed rapid declines of the population that could not find a sound explanation. Only short term prognosis just before and at the beginning of flowering were reliable.

In aim to replace time consuming direct countings by incidence counts the relationship between the aphid density and the proportion infested tillers was studies. It appeared that at 5-10 aphids per tiller there were never less than 60-70% infested tillers. However, at 0.5-1 aphid per tiller there were in some cases up to 60-70% infested tillers, that can explain, at least partly, still high amount of unjustified recommendations for aphid control in many countries. A more exact system of forecasting is proposed. -Only American bird cherry on which *R. padi* does not hibernate should be recommended planting.

THE USE OF ELISA TECHNIQUES TO AID FORECASTING AND CONTROL OF APHIDS IN SUGAR BEET. Dewar, Alan M. (IACR Broom's Barn Experimental Station, Higham, Bury St. Edmunds, Suffolk, U.K.).

The Virus-Yellows Warning Scheme for sugar beet in the U.K. utilises information on virus sources, aphid migrations and mortality of aphids during the winter to provide farmers with advice on use and timing of insecticides to control the aphid vectors. The development of amplified ELISA techniques has allowed us to incorporate data on the infectivity of individual aphids into our information bulletins. The same aphids can also be tested for resistance to insecticides using an immunoassay technique. These two processes allow us to give more specific advice on the need for and timing of insecticide sprays - the first time that such information has been made available for practical application in arable crops in the U.K.

CHARACTERIZATION OF THE RESISTANCE OF CAPSICUM SPP. TO APHID VECTORS. Alberto Fereres, Paloma Perez. (Consejo Superior de Investigaciones Científicas. Centro de Ciencias Medioambientales. Serrano 115-bis. 28006 Madrid), Cesar Gemeno, Mª José Soto, Fernando Ponz (CIT-INIA. Carretera de la Coruña Km 7.5. Apartado 8111. 28080 Madrid).

Insects are the major vectors of virus diseases that occur in open-field pepper crops in Spain. Potato Virus Y and Cucumber Mosaic Virus are two of these major pepper pathogens. Both are transmitted by several aphid species landing on the pepper canopy. A germplasm bank collection of various **Capsicum** species was used to search for resistance to the major aphid species caught in green tile traps over the plant canopy. A total of 74 entries were assessed for an antibiotic type of resistance according to Banks' scale (Banks, 1954) in open field conditions. A no-choice laboratory experiment was designed to analyze the degree of preference that exhibited **M. persicae** alates to settle on excised leaves. Finally, the most promissing entries were selected for studying aphid probing and feeding behaviour with two AC-amplified electronic monitors.

Results indicated that no aphids were able to colonize nor reproduce on 25 of the entries. **M persicae** alates showed a non preference type of response in the no-choice test on 8 of the entries, and 4 of these were resistant or moderately resistant on the feeding behaviour tests. The selected entries were planted in 1991 under very high inoculum pressure in the Murcia region. One of these genotypes behaved specially well under such circumstances.

GREEN PEACH APHID *MYZUS PERSICAE* SULZER, DEVELOPMENT, LONGEVITY AND REPRODUCTIVE BIOLOGY ON SOME COMMERCIAL POTATO. Gh. Reza Rassoulian (Plant Protection Department, Agricultural College of Karaj. Univ. of Tehran, Karaj, Iran)

The green peach aphid (G.P.A) is reported as one of the most important pests of potato. The studies cited by researchers suggest that it may possible to develop resistance of potato to aphid. We compare here the development, longevity and reproductive biology of G. P. A. on eight commercial potato cultivars. Varieties were grown in 155 mm standard plastic pots, After 15 days the grown plants were transferred to an environment chamber set at 20±1°C and 16: 8 light-dark. First instar nymphs were placed on a single leaf of each variety in four replications. The nymphs were examined at 48 hours intervals and development, longevity and reproductive data were recorded and computerised. The results showed that the longevity of adults and reproductive performance significantly reduced on some varieties (Norchip and onaway) compared to other cultivars.

AUCHENORRHYNCHA OF CEREALS IN ITALY. Alessandra Arzone (Institute of agricultural Entomology and Apiculture of the University, 10126 Turin, Italy)

The Auchenorrhyncha dwelling on cereals in Italy are included in the families Delphacidae and Cicadellidae.

Among the Delphacidae, Laodelphax striatellus, Javesella pellucida, Stenocranus major and S. minutus are to be recorded. L. striatellus is especially harmful because it transmits virus diseases to maize, barley, wheat and oat. Actually it is a vector of BYSMV to barley and above all of MRDV to maize. Although it has as common host plants Triticum aestivum and Sorghum bicolor among cereals, it inoculates MRDV to maize when this plant is in the coleoptile phasis, with severe damages to cultivations.

For what concerns Cicadellidae, Cicadulina bipunctata, that transmits several viruses in tropical zones, is reported from Sicily but until now it is not accused to provoke diseases. Macrosteles spp., Cicadulina placida, Mocydia crocea, Psammotettix alienus, and P. confinis are common everywhere without damages. Moreover, ten species of Zyginidia are widely diffused in well defined zones. In particular Z. pullula is noteworthy in northern Italy owing to its rhythmic migrations from grasses to cereals and for its remarkable infestations on maize. However, when the cultivations are not sprayed with insecticides, these cicadellids are very well controlled by their natural enemies.

THRIPS LANDING RESPONSE AND FIELD RESISTANCE OF LYCOPERSICON SP. TO TOMATO SPOTTED WILT VIRUS. Nallur K. Krishna kumar and Diane E. Ullman, Department of Entomology, University of Hawaii, Honolulu, Hawaii 96822, United States of America

Tomato spotted wilt virus (TSWV) is a serious viral disease affecting a multitude of food, fiber and ornamental crops worldwide. In nature, the virus is exclusively, transmitted by several species of thrips, of which the western flower thrips (WFT), Frankliniella occidentalis is thought to be most important. The thrips-TSWV relationship is unusual, as only larvae can acquire the virus. As winged, dispersing stadia, adults primarily transmit the virus. While much has been learned about the TSWV in its plant hosts, thrips landing and feeding preferences, vital to understanding TSWV spread are little understood. The importance of these behaviors in the transmission of TSWV to thirteen promising tomato accessions representing seven species of Lycopersicon were evaluated. WFL landing preference at foliar and flowering stages between June-December, 1991 at Kula on the island of Maui, Hawaii were evaluated. Flowers were significantly more attractive to WFL than leaves, though thrips were recorded on all the accessions on both leaves and flowers. L.esculentum, L. parviflorum, L. pimpinellifolium & L. hirsutum were susceptible to TSWV. L. hirsutum f. glabratum, L.pennelli, L. chilensi, L. chimelewskii, L. peruvianum and the cv. Rey de los tempranos were field resistant. The significance of these findings in the management of TSWV shall be discussed.

POPULATION DYNAMICS OF LEAF- AND PLANTHOPPERS IN THE ORGANIC-FARMING RICE PADDY FIELD AND FACTORS AFFECTING THEIR DENSITY. Tatsuto Kajimura (Okayama University, Tushimanaka,Okayama 700,Japan).

Recently organic-farming products are required by the consumers who demand healthy food in Japan. In organic-farming, no pestsides are used and the organic fertilizer is applicated instead of the chemical fertilizer.

The author censused the population density of the brown planthopper(BPH), Nilaparvata lugens, the white backed planthopper (WBPH), Sogatella furcifera and the green leafhopper(GLH),Nephottix cincticeps in a rice paddy field which has been cultivated rice by organic-farming(OF) for about 15 years and in a conventional practice field(CF) in Okayama,Western Japan,by using FARMCOP suction catcher.

The density of BPH, WBPH and GLH in OF was always extremely lower than that in CF. In 1990, the peak nymphal density of BPH was 7.7 per hill in OF, whereas 120.8 per hill in CF. The peak nymphal density of WBPH and GLH in OF was about 1/6 and 1/5 of that in CF,respectively. The similar trend was also seen in 1991.

Since the density of the natural enamies in OF was lower than that in CF,the lower density of these pests in OF was caused by the difference in the growth pattern of rice and cultivation methods in OF from those in CF. Factors affecting these pests density in OF are discussed.

COMPARATIVE POPULATION DYNAMICS OF THE GREEN LEAFHOPPERS, NEPHOTETTIX SPP., BETWEEN TROPICAL AND TEMPERATE PADDY FIELDS. INYOMAN WIDIARTA (Okayama University, Japan)

The population dynamics of the green leafhoppers, which are vectors of tungro and dwarf diseases were compared between tropical and temperate paddy fields. A FARMCOP suction catcher was employed to survey the population density. Nephotettix virescens (NV) and N. cincticeps (NC) were dominant species in tropical paddy fields in Indonesia and temperate paddy fields in Japan, respectively. The population growth pattern and the level of peak density differs between the two species in each locality, although the reproductive capacity was similar to one another. The density of the most populations in the tropical paddy fields increased only during early stages of rice. On the other hand, the density of population in temperate paddy fields increased throughout the rice growing stage and reached much higher peak density in the late stage of rice. The difference in the population dynamics between NV and NC could not be explained by the differences in the factors such as densities of predators, parasitism, the BPH as a possible competitor, and effect of indica and japonica rice which are transplanted in each locality. The residential period of NV was shorter than NC and number of eggs laid by NV were much lower than NC in late stages of rice.

POPULATION DYNAMICS OF THE GREEN RICE LEAFHOPPER, *NEPHOTETTIX VIRESCENS*, AN EFFICIENT VECTOR OF RICE TUNGRO DISEASE. Yoshito Suzuki, I N. Widiarta (Directorate of Food Crop Protection, Jakarta, Indonesia) and I. G. N. Aryawan (Food Crop Protection Center VII, P.O. Box 88 Denpasar, Bali, Indonesia)

N. virescens is the most important vector of tungro, a destructive rice disease in asynchronous rice planting areas in tropical Asia. A 4-year field study made in tungro-endemic areas in Bali revealed that tungro outbreaks were triggered by the population buildup of *N. virescens* at around the start of wet season. The key factor causing the population fluctuations of *N. virescens* was the combination of nymphal mortality and adult losses including emigration from the field. However, no significant correlation was detected between various indices of natural enemy activities and the nymphal mortality. This indicated that seasonal changes in migratory activities of adults were largely responsible for the population fluctuations: high emigration rates of the 1st generation adults in early wet seasons contribute to the areal population increase through their colonization into young paddy fields where conditions for reproduction and survival of their progeny are favorable.

RICE PLANTHOPPERS, NILAPARVATA LUGENS AND SOGATELLA FURCIFERA IN THE MUDA AREA, WEST MALAYSIA: DOES THE CROP-FREE FALLOW PERIOD SUPPRESS PLANTHOPPER POPULATION ? WADA Takashi (Kyushu Nat. Agr. Exp. Sta., Nishigoshi, Kumamoto, 861-11 Japan) and NIK M. Noor (MARDI Alor Setar, P.O. Box 105, Alor Setar, Kedah, Malaysia)

A crop-free fallow period is often settled to suppress planthopper populations in the tropical rice area. In Muda, however, it increased the instability of the biotic community and hence favored the planthoppers.

Muda irrigation scheme comprises ca. 100,000 ha double-cropping paddy fields. A month or longer crop-free fallow period has been introduced in the dry season since 1984, mainly for eradicating tungro-infested plants. In the 1st crop of 1990, most hopperburn cases occurred in the fields where rice was planted soon after the fallow period (early-planted fields). Field population surveys also showed a similar tendency: the populations of both N. lugens and S. furcifera in the early-planted fields reached high densities through a few generations, despite very low initial immigrant densities. On the other hand, the planthopper populations in the late-planted fields retained very low levels throughout the crop season in spite of the invasions of abundant immigrants in the early rice stage. This difference in the population growth pattern was attributed to the activity of the natural enemies. The fallow period destroying natural enemy fauna favored the multiplication of planthoppers which are adapted for unstable environments.

FACTORS CONTRIBUTING TO THE REGIONAL DIFFERENCE IN ABUNDANCE OF THE GREEN RICE LEAFHOPPER, NEPHOTETTIX CINCTICEPS IN JAPAN. Hirowo Satomi (Hokuriku National Agricultural Experiment Station, Joetsu-shi, Niigata-ken, 943-01, Japan)

Seasonal population trend and the peak density of N. cincticeps are quite different each other between southwestern and northeastern Japan. Kuno (1968) reported that in Kyushu (SW Japan) the density in the peak generation was 14 per hill in average and the yearly fluctuation was very small. He concluded that population density of this species is self-regulated through density-dependent dispersal of adults. But, Johraku et al. (1983) showed that in Hokuriku (NE Japan) it reached to 77 per hill at the highest of four years. Though several studies have been conducted to detect the difference in regulatory mechanism between the both populations, it is still obscure.

Difference in seasonal abundance between the two regions is mainly attributable to that in the reproduction of 2nd generation. In Hokuriku the population density in paddy fields remarkably increases from 2nd to 3rd generation, but in Kyushu it rather decreases. In my field and pot experiments, the egg density in 3rd generation was found to be much higher on early varieties of rice after heading than on late varieties before heading, and the fecundity of females in 2nd generation was much less in a rice field transplanted in mid-June as in Kyushu than in one transplanted in mid-May. It is concluded that the regional difference is mainly due to the differences in cropping period and maturity of rice plant between both regions.

QUANTIFICATION OF PHOTOSYNTHATE DRAIN BY DELPHACID POPULATIONS ON RICE. Kazushige Sogawa (Laboratory of Pest Management Systems, Kyushu National Agricultural Experiment Station, Nishigoshi, Kumamoto 861-11, JAPAN)

Economic importance of rice Delphacids, Nilaparvata lugens and Sogatella furcifera as insect pests of rice have been documented extensively, but much less have been analyzed the physiological processes of yield reduction in the crop due to sucking by these pests. Their sucking sites are highly localized to the phloem in the host plants, in which photosynthate is translocated. Thus, the Delphacid populations could be evaluated as extra sinks stealing photosynthate of rice plants.

Rates of photosynthate drain by nymphs and adults of the both Delphacid species were quantified by measuring the amounts of honeydew excreted, assimilation including egg production, and metabolic cost estimated on the dry matter basis. The effects of host plant age and temperature on the rates of drain were also acertained.

Dynamics of photosynthate drain during the process of population growth of the both Delphacid species were simulated coupling the drain parameters to the insect population models.

Studying applied Agrotechnical Methods to rice stem borer "Chilo suppressalis walk" In Guilan. Salehi Latif (College of Agriculture University of Guilan, P.O.Box 41335-3179, Rasht-IRAN), SAEB, H. (Plant pest and diseases Research, Institute of Guilan, P.O. Box 133-IRAN).

.The rice stem borer was seen for the first time in 1973 in the rice farms of Northern Iran, and after two years covered the entire farmlands of Guilan. During the year 1986 - 1989 a commen project known as agrotechnical method in collaboration with two scientific and research centres was implemented. This project was done in 3 different villages in Guilan. Each village had about 20 hectares of rice farm. Two of the first villages were isolated, and there was no rice farming till a radius of 20Km , and the third, Unisolated, was on the side of other rice farm. The investigations started by plowing twice in two directions , going on by floating irrigation, destroying weeds, establishing nurseries and posting Petrol-Light traps to estimate the population of the first generation, removal of eggs, estimation of hibernating larvae in tensity, determination of the ratio Dead heart and white head. Under optimum candition the following results have been obtained. 1/ We can decrease the amount of first time application to $\frac{1}{2}$ rice cultivation at Guilan proince, because the first generation population density and dead heart rate are actually. 2/ We can omit first and second spraying on early-maturity and intime harvesting usually take place a little more earlier, because we will harvest all crops beforedamage of the second generation larvae and occurrence of white head.

SYSTEMS APPROACH FOR INTEGRATED MANAGEMENT OF BROWN PLANTHOPPER, *NILAPARVATA LUGENS* STAL. Wei-jian Wu, Xiong-fei Pang (Lab. of Insect Ecology,South China Agricultural University, Guangzhou, 510642,China)

A great progress has been made in the application of system science techniques to insect ecology and integrated pest management of brown planthopper(BPH), *Nilaparvata lugens* , one of the main pests on rice. The systematic analysis method to evaluate the optimal combination of tactics used to manage BPH was presented in the paper.

Based upon the life tables and submodels, the method of state space expressions of the modern cybernetics was introduced to discuss the control of BPH population system. The results showed that (i) the control factors must act on fecundity or states of the population if the system was controllable; (ii) the principle factors controlling BPH population were natural enemies and varietal resistance; (iii) selective insecticides and moderate resistant variety were the optimal combination of the four strategies studied.

THE LIFE TABLE OF EXPERIMENTAL POPULATION OF SOGATELLA FURCIFERA AT DIFFERENT HUMIDITY. Zheng-xiang Ye, Hou-guo Qin, Rong-hua Huang (Institute of Plant Protection, Jiangxi Academy of Agricultural Sciences, Nanchang 330200, China)

The paper analysed the populational growth of Sogatella furcifera at 5 humidities, and constructed the life table of experimental population. The results showed that the durations of egg stage and nymphal stage didn t change significantly under condition of 43-100% relative humidity. With the increase of humidity, the change of egg hatching rates, survival rates of nymphs, survival rates of generations, numbers of eggs laid, longevities of adults, intrinsic rates of increase and trend indices of population took the shape of parabola. The population could grow at any humidity of the 5 treatments. The optimum humidity for egg hatching, nymphal survival and generation survival ranged from 80% to 92%. At 80% relative humidity, the longevity of adults was longest, the number of eggs laid was greatest and the number of adults laying no egg was smallest.

INVESTIGATION ON APPLIED AGROTECHNICAL METHODS FOR RICE STEMBORER *CHILO SUPPRESSALIS* WLK.CONTROL IN GUILAN. H. Saeb[1], H. Rahimian[2], Z. Karimian[1], M. Heydari[3], A. Vakili[4], M. Djalali[4], and L. Salehi[5] (Iran)

[1] Plant Pests and Disease Research Institute of Guilan, P.O. Box 133, Bandar Anzali, Iran
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[5] Agricultural College of Guilan University, Iran

The rice stem borer (RSB), *Chilo suppressalis* Walker, was reviewed for first time in Iran at 1972. After a few years, it became a major pest of rice. By reason of low density population of first generation and haryesting of early maturity and intime varieties, and for purpose of preventing poisonous effects of insecticides, we started jointly the above design at 1985 and was conducted for 3 years in two isolated villages (20 ha each village) and one un-isolated (10 ha) which were not sprayed against RSB and some rice fields as control. The results showed that:

1. Collecting and burning of all weeds in rice fields and borders, land preparation for transplanting, and other agrotechnical methods must be implemented before emergence of first RSB pupae.

2. We can reduce the amount of first spraying to 1/2 rice cultivation of province, because the population desity and the rate of dead heart is low.

3. We can eliminate first and second spraying on early maturity and intime varieties, when climatic condition is favourite, because before damage of second generation larvae and occurrence of white head, we will harvest all crops.

EFFECT OF RICE VARIETY ON POPULATION GROWTH OF BROWN PLANTHOPPER. Jiaan Cheng (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou, 310029, China) and Xiangliang Sun (Agricultural Institute of Jiaxin, Zhejiang, China)

Eight rice varieties, which are 8204, 8533, Nonghu3-2, Ce 48, Xiushui 620, Xiushui 664, Xiushui 678 and Shanyou 6, were selected as exprimental materials to test their effects on 11 population parameters related to development, survival and reproduction of brown planthopper. The results included that Xiushui 620, 664 and 678, as well as Shanyou 6, could extend development period of nymph, reduce survival rate of nymph and fecundity, increase the variance of population parameters in adulthood, such as number of eggs laid per female, continued ovipositing time and longevity of female adults. Fed with the varieties of Xiushui620, 664 and 678, the rm of BPH population delined, the mean length of generation and doubling time of population extended, and the net reproductive rate decreased by 80 to 90 percent compared with control. The main factors affecting the innate capacity for increase are the decline in fecundity and nymph survival rate. The main reasons for the extension of mean length of generation are the extension of nymph period and the change of survival and ovipositing dynamics at adulthood stage. However, when rearing on Xiushui 620 and Xiushui 664 continuously, the survival rate of nymph in the third generation increased significantly. Field experiments confirmed that Xiushui 620 and Xiushui 664 could suppress population growth of BPH substancically with the peak size of the main damaging generation reduced by 79.9 and 72.5% respectively and the emergence time delayed.

ADVANCE IN STUDY OF RICE VARIETIES RESISTANCE TO INSECT PESTS IN CHINA.

Zhen—Yuan Gu, (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences, Nanjiang 210014, China)

Obvious differences of resistance to rice pests could be found between japonica and indica. In general speaking, the level of resistance to SB and WBPH in japonica is higher than in indica. The gerplazm resources which resistance to main rice pests have been screened. Among of them, there are not only indica, but olso japonica. Genetic analysis on several germplasms which resistance to BPH, WBPH and GM has been conducted. The result showed that the resistance is controlled by major gene (or genes). More than 20 resistant varieties such as Weiyou 35, Xiushui 620, Nanjing 14 al. have been cultivated. These varieties are grown about 4million hectares in one season. According to the result of investigation from 1980 to 1990, BPH in our country is biotype 1 mainly. But the supperior BPH population in Guang—Xi region has changed from biotype one into two since 1987. Gall midge occurs in thouth china, and 4 biotypes were discovered. Varieties which restance to planthopper show nonpreferce and antibiosis. Mechanisms of resistance relate to the content of amino acid and the activity of glutamate decarboxylass. Varieties which resistance to rice stem borers such as Xiaoqing , lianken 1 showed that the gas cavity diameter of leaf sheath is smaller, the distance between vascular bundles is shorter, the number of silica cell in leaf sheath is larger, and the sugar content in rice plant is lower. The resistance to leaf forlder relates to the water content in leaf. The resistance is steadily stronger along which the water content in leaf is lower.

BIOLOGY AND POPULATION MANAGEMENT OF THE DIAMONDBACK MOTH IN ILLINOIS (USA).

H. Oloumi-Sadeghi, C.E. Eastman, K.L. Steffey (Illinois Natural History Survey, 607 E. Peabody Dr., 172 Natural Resources Bldg., Champaign, IL 61820, USA)

The diamondback moth (DBM) is a worldwide pest of cruciferous crops. DBM is becoming a major insect pest in USA primarily because of development of resistance to the commonly used insecticides. In Illinois, crops such as cabbage, broccoli, mustard greens, and horseradish are damaged by this insect, and new crops such as canola (low-acid rapeseed) can also serve as hosts for fall and spring populations. We studied the dynamics of DBM in several horseradish fields during the 1988 and 1989 growing seasons in Illinois. Sex attractant traps were installed in these fields to monitor the adult populations, and plant samples were collected from the fields to determine the number of generations, egg density, and patterns of adult emergence. Effects of natural mortality factors and effectiveness of microbial insecticides derived from *Bacillus thuringiensis* var. *Kurstaki* on field populations of DBM on cabbage were also studied. For the last three years we have conducted laboratory studies of biological characteristics of this insect such as mating behavior; preoviposition, oviposition, and postoviposition periods; oviposition preference; ovarian development; and fecundity and longevity of adult moths. This information is of value in the identification of proper tactics for the management of DBM populations.

ON RELATIONSHIP BETWEEN THE FREE AMINO ACIDS CONTROL AND RESISTANCE TO *NILAPARAVATA LUGENS* IN RICE VARIETIES.

Ling Zeng, Jung-tsung Wu. (South China Agricultural University, Guangzhou, 510642, China)

The resistance to *Nilaparavata lugens* (NL) in 4 rice varieties at 30, 45, 60-day-old plants and the correlations between the content of various free amino acids taken in rice sheath and 4 resistant parameters including damage rating, amount of honeydew excreted, nymph survival and fecundity were studied. The results indicated that the total content and the content of mainly free amino acids in susceptible variety TN1 were higher than resistant variety 7105 in different growth ages. Generally the total content of free amino acids in the moderate resistant varieties Baosyan 2 and Fubaoai 21 were higher than in 7105 but lower than in TN1. The positive correlations significantly existed between the content of 4 amino acids (Phenylalanine, Valine, glutamic acid and isoleucine) and 4 resistant parameters, also existed between the content of other 3 amino acids(asparagine, aspartic acid and leucine) and 3 resistant parameters.

THE ANTIFEEDING EFFECTS OF α-TOMATINE TO THE LARVAE OF DIAMONDBACK MOTH.

Yau-i Chu (Department of Plant Pathology and Entomology, National Taiwan University, Taipei, Taiwan, China), Feng-Ming Lu (Department of Plant Protection, Fengshan Tropical Horticultural Experiment Station, Taiwan Agricultural Research Institute, Fengshan, Taiwan, China)

Crystal α-tomatine was dissolved with 50% EtOH and prepared 0.1, 0.2 and 0.4% solution. Then a piece of cabbage leaflet was dipped into tomatine solution for 30sec.. After the excess solution on the leaflet evaporated, a certain instar stage larvae of diamondback moth (DBM) was inoculated on the leaflet. Then the growth and feeding ratio were estimated.

When the 1st instar larvae were reared with 0.4, 0.2 and 0.1% solution treated leaves, till the 4th instar stage, the daily intake leaf area through the tested duration were 1.1, 1.5, 6.5 mm^2 respectively. Those are equivalent to 1/34 - 1/6 of the fed area of the water-treated leaf. In the case, the larvae fed on 0.1% solution treated leaf since their 1st instar stage, only 20% of tested larvae grow to the adult. In 0.2 and 0.4% solution treated groups no larvae grow to 3rd instar stage. When 4th instar larvae are afforded with treated leaves, about half of tested larvae grow to the adult.

DEVELOPING AN INSECT MONITORING SYSTEM FOR RICE FARMERS IN THE PHILIPPINES.

Celia dlR Medina, Luis Rey I. Velasco and Jose S. Soriano, Jr. (Department of Entomology, University of the Philippines at Los Banos, College, Languna 4031, Philippines).

The insect monitoring practices of rice farmers in in selected areas in the Philippines were studied to develop an efficient and practical insect monitoring system. The multi-phased study consisted of a survey-interview, an in depth on-farm observation and consultation with farmers and an evaluation of the devised monitoring scheme. In the first two phases of the study, the general features and peculiarities of the insect monitoring practices of farmers were documented and analyzed. Farmers were found to monitor their fields regularly for insect pest number and damage, but this activity was undertaken more often as an integral part of the other farm routines. Some social and economic factors significantly influenced their insect monitoring methods. Based on the capabilities and needs of the farmers, several aspects of their conventional method of insect monitoring were modified and improved. The initial evaluation of this insect monitoring scheme is included in this paper.

FACTORS AFFECTING ON FECUNDITY OF DIAMONDBACK MOTH, PLUTELLA XYLOSTELLA.

H. Uematsu and A. Sakanoshita (Faculty of Agriculture, Miyazaki University, Miyazaki 889-21 JAPAN)

Fecundity of diamondback moth (DBM), an important pest of crucifer, was studied in the laboratory and the field conditions in Miyazaki, southern part of Japan. DBM reared on seedlings of Japanese radish or rape were able to lay more eggs than those reared on white heart leaf of cabbage. Fecundity of virgin females was 60 % of the mated females. Fecundity of females fed on 2% sugar solution was increased in 1.4 to 1.6 times of those fed on water only. Although the fecundity of DBM collected from natural field were varied with the seasons they were sampled, there were no difference in fecundity between DBM in the incubator controlled 20 °C and ones in a meteorological instrument shelter. This indicates temperatures of cold (winter) or hot (summer) do not work to lower the fecundity of DBM. Experiments also suggested that variations in size of female DBM is most important source in scattering of the data on fecundity.

Insecticide management for the control of the diamondback moth, Plutella xylostella (L.) with emphasis on abamectin

Weerawooth Katanyukul Wanchai Rattanadechakul
Hoechst Thai Ltd.
302 Silom Road, Bangkok 10500, Thailand

Diamondback moth (DBM) is one of the most destructive insect pests attacking cruciferous crops in Thailand. The insect is widely distributed throughout the vegetable growing area, however severe damage is mostly found in the Central plain where vegetables are grown commercially all year-round. Due to the severe infestation, insecticides are heavily used and very often many of them failed, within a short period of time, to give effective control, after being introduced due to insect resistance.

Abamectin, a new generation insecticide, was recently introduced to combat DBM. In order to prolong the life of the product by delaying resistance development, components of insecticide management were studied such as treatment threshold, insecticide alternation, and additionally effect of different insecticide sprayers. The results of the study, were implemented in the field through farmer's meetings complemented by marketing techniques.

AN INVESTIGATION ON THE BIO-ECOLOGY OF SCOTIA OBESA BOISD IN WEST AZARBAIDJAN, IRAN. **Heydar Adldoost** (Agricultural research center, Urmieh, Iran P.O.Box 365)

Scotia obesa Boisd a yellow cutworm,cause damage to rainfed chickpea and sunflower in uplands of West Azarbaidjan. This insect has one generation per year. Adults emerge in September and females deposit their eggs on the soil.

Hatching start in November and 2nd instar larvae hibernate during December-March. In late March, before planting of crop, the pest feed on weeds and later on growing young plants. In late June the larvae grow to full size, but before pupation, estivate under the soil until late August. During the September all larvae pupate and adults emerge in 21-24 days.

INTEGRATED CONTROL OF TOMATO LEAFMINER, Liriomyza bryoniae (Kalt.) ON MUSKMELON. Ching-Huan Cheng (Chiayi Agricultural Experiment Station, TARI., Chiayi, Taiwan,China)

The tomato leafminer (Liriomyza bryoniae (Kalt.))(Diptera: Agromyzidae) has become one of destructive insect pests of Cucurbitaceous crops in Taiwan recently. Besides, the leafminer also cause severe damage to the crops belonging to Solanaceae, Compositae and Cruciferae. It took about 17 days to complete a life cycle at 25°C on muskmelon leaves. Threshold temperature for the development of egg, larva and pupa were about 10, 8 and 7°C, respectively; and sum of effective temperature for egg was 31.8, larva 85.1 and pupa 158.2 day-degree C. High temperature over 30°C had adverse effect to their development. Population density of the leafminer was highly correlated with the season and the abundance of the host plants. However, the outbreak of this insect pest was belived due to improper uses of insecticides to eliminate the natural enemies. In order to curb severe infestation of the pest, an integrated control system was then developed recently by combination use of resistant plant, yellow water-pan trap and proper use of selected insecticides. Preliminary result of control with this system reduced the cost of control to more than 50%, and increased the parasitism of the pest remarkably.

EFFECTS OF MIXED CROPPING ON RESISTANCE AND SUSCEPTIBLE OF COWPEA CULTIVARS TO MARUCA TESTULALIS GEYER. Macharia Gethi and Eliud Omolo (Regional Research Center EMBU, P.O. Box 27 EMBU, Kenya)

Results obtained revealed that larval population of Maruca was significantly different according to varieties, cropping systems and seasons. These differences were associated more on intercropping than to resistance or susceptibility.

However, the role of resistance and susceptibility was realized during the initial colonisation on cowpea. Pure stands of both resistant (Tvu 946) and susceptible (ICV 2) cultivars had significantly higher larval population. The incidences of Maruca larvae were higher during the long rains than during the short rains. Similarly results indicated that mixed cropping affected the relative resistance and susceptibility of cowpea cultivars. These changes were attributed to the micro-environments that were created by maize.

AN INVESTIGATION ON THE BIO- ECOLOGY OF *SCOTIA CRASSA* Hb IN WEST AZERBAIDJAN, IRAN. **Heydar Adldoost** (Agricultural Research Center, Urmieh, P.O. Box 365, Iran)

Scotia crassa Hb a cutworm, cause damage to rainfed -- chickpea and sunflower in uplands of West Azarbaidjan. This insect has one generation per year. Adults emerge in September and females deposit their eggs on the soil. Hatching start in November and 2nd instar larvae hibernat during December - March.

In late March, befor planting of crop, .The pest feed on weeds and later on growing young plants. In late june the larvae growth to full size, but befor pupation, --- estivate under the soil until mid August. During the --- August and September all larvae pupate and adults emerge in three weeks.

EFFECT OF SCAPTOMYZA FLAVA ON THE YIELD OF TURNIP AND CHINESE CABBAGE Ali A. Seraj, Ph. D. student at Massey Univ.New Zealand.

Scaptomyza flava (Dipt. Drosophilidae) is a native leafminer which occurs throughout New Zealand.
When the S. flava, was held in the laboratory, an av. of 130 eggs were laid.
Adult longevity averaged 3 wk, and sex ratio was 1:1 or a slight bias in favor of males. Total time reqired for development was 4 wk at 20 C°.
The majority of adults mate soon after emergence. Protracted copulation is 20 min-1 hr. Maximum mating time is about 2 hr.Male and females mate more than once. Under greenhouse and laboratory conditions, most female begin oviposition within 36-48 hr after emergence. Females generally lay the majority of eggs between days 7-18 of adult life.
Fecundity has been measured, S. flava females produced an average of 130 eggs when offered honey solution and 100 when offered yeast and 140 when offered mix of honey and yeast and 89 when offered water only.
Longevity depends on access to food: S. flava females lived 20 days with access to honey solution (without host plant) and 10 days with water only and lived 2 days on glass plates (starved).

WOUND INDUCED ANTIXENOTIC RESISTANCE IN CRUCIFERS TO FLEA BEETLES, *PHYLLOTRETA CRUCIFERAE* (GOEZE). P. Palaniswamy and R.J. Lamb. Agriculture Canada Research Station, 195 Dafoe Road, Winnipeg, Manitoba, Canada, R3T 2M9.

The effect of damaging seedlings of oilseed rape (*Brassica napus, B. campestris*) and yellow mustard (*Sinapis alba*) on subsequent feeding rate of flea beetles was studied in the laboratory. One of the two cotyledons of 7-day old seedlings were damaged mechanically by puncturing them with needles or by exposing them to flea beetles. Eight or 24 h following the damage, these damaged seedlings (treatment) were paired with undamaged seedlings (control) and exposed to flea beetles in plexiglass arenas. Damage estimate on control plants and the previously undamaged cotyledons of the treatment plants indicated that the treatment plants exhibited greater antixenotic resistance than control plants. This effect was more pronounced in some plant species than others, and in some cases the effect lasted up to the first true leaf stage.

THE PRACTICAL IMPLEMENTATION OF IPM ON CABBAGE IN INDONESIA. Irbansyah, B., D. Nevill, A. Triwiyono (Ciba-Geigy, P.O. Box 135, Jakarta, Indonesia), S. Sastrosiswojo (Lembang Horticultural Research Institute (LEHRI), Lembang, Indonesia).

Cabbage farmers from West Java village of Pangalengan were trained in IPM by LEHRI in cooperation with Ciba-Geigy. For the practical implementation of this IPM programme, threshold of 0.5 larvae/plant for Plutella xylostella and 0.3 egg-masses/plant for Crocidolomia binotalis were used. A simple sampling method to assess population of P. xylostella and C. binotalis allowed farmers to reduce number of insecticide application from 10 - 15 sprays per season to 3 - 4 times only. In a pilot project, the farmers themselves showed that they could reduce the use of insecticide but maintain yield and quality of the cabbage. The farmers also learned that the parasitoid wasp Diadegma semiclausum was an important natural control of P. xylostella populations and insecticide application should have minimal influence on this beneficial insect. In order to succesfully implement IPM, it was essential for farmers to understand in simple term the biology of pests and beneficials and to learn about safe and effective insecticide application in an appropriate use-strategy. Furthermore, they needed simple scouting aids and initial field support until they had gained confidence in the system.

BIOLOGY AND CONTROL OF CEUTORHYNCHUS MACULAALBA HERBST /COLEOPTERA:CURCULIONIDAE/ IN HUNGARY. Gy.Sáringer /University of Agricultural Sciences, 8360 Keszthely, P.O.Box 71,Hungary/

In Hungary C.maculaalba is the most dangerous pest of Papaver somniferum L. C.maculaalba has a single generation a year. It is only able to place its eggs in 1 to 2-day-old capsules. The excitation mechanism of egg laying is: 1. in response to the fragrance of flowers as an olfactostimulus the female adults gather in the poppy flowers: 2. the specific stimulants of the capsule, as contact chemostimuli induce mastication of the adults, then with the third stimulus - the roundness of the capsule as a form stimulus - added to the former two the female adult is moved to pierce the capsule with its proboscis and place its eggs through the hole thus made in the capsule. The antennae also play a decisive role in egg laying. Even such adults as possessing mere scapes are able to lay eggs,while those without scape do not lay eggs. The temperature threshold for eggs and larvae is 13°C.In Hungary the species Bracon longicaudis /Hym.,Braconidae/ was raised from C. maculaalba larvae. Twentyone per cent of the larvae were parazitized /1986/.

COLORADO POTATO BEETLE, LEPTINOTARSA DECIMLINEATA (SAY) (COLEOPTERA: CHRYSOMELIDAE), CONTROL WITH ROOT BARK POWDER OF CHINESE BITTERSWEET (CELASTRUS ANGULATUS MAX.) IN FIELD AND LABORATORY TRIALS. Robert L. Stoltz, N. Matteson (Department of PSES, University of Idaho Research and Extension Center, Twin Falls, ID 83301) and Wenjun Wu (Plant Protection Department, Northwestern Agricultural University, Yangling, Shaanxi, 712100, China).

Field applications of a wettable powder of Chinese Bittersweet root when applied at rates of 1.2 and 3.1 kg/ha (two applications 7 days apart) provided from 38-90% reduction of small larvae, 46-86% reductions in large larvae, and 45-81% reductions in defoliation of potato plants. The higher rate provided greater degrees of control and less defoliation. Petri dish studies with leaf discs dipped in serial dilutions of bittersweet solutions showed significant reduction in leaf tissue consumed as concentrations increased. Upon feeding on treated leaf surfaces, most larvae immediately became lethargic and ceased feeding.

RELATIONSHIP OF LEPIDOPTERA INFESTED FRUIT TO LARVAL FRAGMENTS IN PROCESSED TOMATOES. Frank G. Zalom (Department of Entomology, University of California, Davis, 95616, USA), and Allan Jones (Processing Tomato Advisory Board, 3960 Industrial Blvd., Suite 100, West Sacramento, CA 95691, USA)

All processing tomatoes harvested in California for delivery to canneries are inspected by Processing Tomato Advisory Board inspectors under direction of the California Department of Food and Agriculture. The maximum tolerance for damage by Lepidoptera larvae in a load of tomatoes is 2% by weight.

Samples of tomatoes with known percentages of larvae or damaged fruit were processed, and samples of the finished product were analyzed to determine the number of larval fragments in a 200 ml juice sample. Two test lots were processed on each of five days of testing. Each lot consisted of six larva-free, 50 pound tomato samples to which larvae or damaged tomatoes were added so that a sample contained either 0%, 1%, 2%, 3%, 4% or 10% adulterated fruit by weight. Larvae and damaged fruit were added based upon a statewide model of damage created from fruit samples sent from 30 of 41 inspection stations and characterized by species, larval size, and extent of damage to each fruit. In addition to percentage of adulterated fruit, treatments included use of different size screens to remove objects during processing, and a comparison of addition of laboratory reared worms and actual worm damaged fruit removed from loads by inspectors.

From the statewide analysis of worm damage, 27.8% of damaged fruit actually contained a larva. Of larvae identified, 76% were *Helicoverpa zea* and 15% were *Spodoptera* spp. The number of damaged fruit by weight prior to processing was significantly correlated to the number of fragments present in the finished product. Screen size reduced the number of fragments in the finished product. Artificially reared and introduced larvae resulted in fewer fragments than the naturally infested fruit.

DAMAGE PATTERNS OF FLEA BEETLES, *PHYLLOTRETA UNDULATA*, ON *BRASSICA NAPUS* CULTIVARS. Barbara Ekbom (Swedish University of Agricultural Sciences, Department of Plant and Forest Protection, Box 7044, S-750 07 Uppsala, Sweden)

Five cultivars of *Brassica napus* were tested for their susceptibility to flea beetle, *Phyllotreta undulata* (Coleptera:Chrysomelidae), attack. *Sinapis alba*, which is known to be more tolerant to flea beetle attack, was included for comparison. Three different methods were used. 1) Field trials where damage was assessed by seedling counts and direct damage to cotelydons. 2) Semi-field trials where all cultivars were germinated in the lab so that they would be the same size when exposed to natural populations of flea beetles. 3) Choice and No-choice tests in the greenhouse. For choice tests one cultivar of *B. napus* and *S. alba* were used.

One of the fastest growing cultivars, Kunto, did well in the field. Differences in damage measured in the semi-field and greenhouse trials were uneven. A concentration of attack on certain leaves in greenhouse tests and on adjacent plants in semi-field tests was detected. Plant phenology in relationto flea beetle damage is discussed.

ON THE NATURAL SPECTRA OF APPLE CANOPIES DAMAGED BY DIFFERENT SPIDER MITE POPULATIONS. Rui-hua Jin, Ke-xun Huang, Yu-chuan Qin, Hong Chen (Department of Plant Protection, Beijing Agricultural University, Beijing 100094,China), Jia-sheng Wang, Hong-ming Zhang, Zhi-guang Lu, Zhong-hui Jin (Institute of Remote Sensing Research, Beijing Agricultural University)

There is close relationship between the density of spider mites, mixed populations of Tetranychus viennensis Zacher and Panonychus ulmi (Koch), and the extent of their damage to apple canopy. In this paper, the natural spectrum characters of the apple canopies damaged by different spider mite populations was tested, attempted to estimate the densities of spider mites with the reflectance in given wave bands, and a series of forecasting equations were preliminarily developed as follows: Model 1, based on the reflectance in wave band I (500-600 nm): $\hat{Y}_1 = 0.4667 X_1 - 1.2472$ ($r_1 = 0.9514^{**}$, $F_1 = 47.7131^{**}$, $SE_1 = 0.7288$). Model 2, based on the reflectance in wave band II (600-700 nm): $Y_2 = 0.7058 X_2 - 5.2625$ ($r_2 = 0.9760^{**}$, $F_2 = 100.5289^{**}$, $SE_2 = 0.5151$). Model 3, based on the reflectance in wave band III (700-800 nm): $Y_3 = 15.8223 - 0.3800 X_3$ ($r_3 = -0.9408^{**}$, $F_3 = 38.4943^{**}$, $SE_3 = 0.8023$). Model 4, based on the reflectance in wave band IV (800-1100 nm): $Y_4 = 20.6706 - 0.4366 X_4$ ($r_4 = -0.9063^{**}$, $F_4 = 22.9857^{**}$, $SE_4 = 1.0003$). It may be a speedy and handy way for spider mite population monitoring.

Agrotechnicol methods of controling the populotion of rice Stem-Borer " Chilo suppressalis wolk.(Lep.Pyrolidae)in Mazondoron (Iron). A.Kharozi-Pokdel[1],M.Heydori[2],A.T.Vokili[3],A.M.Arob[3],M.S.Alovi-Pour[3] ond M.Voli-Pour[3].
1-Plont Protectian Dept.University of Tehran,Koroj 2-Plont pests and Diseases Reserch Institute,Evin,Tehron 3- Plant protectian Organiztion Evin,Tehron.

Agrotechnical methods,were corried,during 3 yeors(1985-87) on 40 ho,for the first step,and olso it wos continued on 1991,an 600 ho of rice field in Mazondoron.

Methods:Two vertical plowing ,flooting irrigation,lond preporation,weeding,estimote the population density of first generation by the petrol-light trops,gathering of eggs,chemicol treotment of the nurseries,evaluotian of hibernating lorvoe intensity,determinotian of the rotio of Deod Heort ond White Heod,ontogenic study of different generotions.

Conclusions:(1),The density of pest on the early ond mid varieties,will diminish to such extent that no chemical contraling,will be necessory.(2),The intensity of the activity of the second generotion ond the young larvoe of the third generation on the lote vorieties,like Amol 3 ond also on lote cultivoted mid vorieties requiring only one chemicol treotment.

OVERCOMPENSATION, A CHALLENGE OF STUDY IN INTEGRATED PEST MANAGEMENT. C. F. Sheng (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The author collected a large number of evidences showing that the overcomopensation of crops for insect feeding or mechanical damage exists widely. These crops include cotton, okra, tomolo, potato, egg plant, melon, cucumber, bean, peanut, vegetable, cereal, sunflower, sesame, sweet potato, beet, safflower, lotus, lily crops and fruit trees. The major internal and external factors determining the overcompensation are properly of crop variely, growth stage, feeding amount, feeding site, and water, fertilizer, energy, time, as well as space available in the environment. These factors relate to each other and function in a combining manner. The overcompensation occurs when the stress of limiting factor is reduced to a certain extent. Compensation is an adaptation of a crop to the fluctuating environment. The basic reason for overcompensation is believed to be a reduction of growth redundancy of crop plants either by insect feeding, crop breeding or growing practices. And the growth redundancy is generally found, especially under the conditions of intensive farming. The overuse of insecticides is due to the lack of study of the overcompensation. Searching for and enhancing the overcompensation are expected to improve the present integrated pest management, which is demonstrated in control of cotton insects in China.

COMPARATIVE STUDIES ON THE THERMOTOLERANCE AMONG VARIOUS STRAINS OF THE SILKWORM, *BOMBYX MORI* L. Feng-kuo Hsieh, Shin-jin Yu, Shin-Yuan Su, Shu-jen Peng (Taiwan Apicultural and Sericultural Experiment Station, 261 Kuannan, Kungkuan, Miaoli, Taiwan, China)

Newly-hatched larvae after heated in water bath were placed inside of glass tube and maintained at 44, 45, 45.5 and 46°C for 1hr, respectively. The mortality count were 0, 12, 87 and 100%, respectively. Larvae killed by severe heat-shock treatments could be reduced by a prior exposure of larvae to a sublethal heat-shock treatment at 40°C for 30min-8hr. Treatment by a heat shock of 40°C for 6-8 hours, followed by a 25°C recovery period (2hr) and a subsequent 47°C/1hr shock treatment, all larvae were found to survive easily. Same results were shown in the different instar, whereas the lethal temperature was lower. Fat-body cells and hemocytes of fifth-instar larvae were collected after a severe 40°C/1hr shock followed by a 25°C recovery period (2hr), and their proteins were compared with O'Farrell's two-dimentional gel electrophoresis. Three heat-shock-specific spots were found , and their molecular weight were about 60-90kb. The normal physiological temperature ranges are 22-25°C in the fifth instar, they appeared the same heat-shock-specific spots as the temperature elevated 10-15°C higher. Two polyvoltine and four bivoltine silkworm strains were reared at the room temperature (25±1°C), high temperature (36±1°C), and fluctuated temperature at 12hr intervals. The results showed that, besides the 1st instar, the high temperature affected more seriously the survival rate. The polyvoltine strains were more tolerant to heat than bivoltine strains at the 4th and 5th instars, and the pupal stage. Among bivoltine strains, the Chinese race "Feng" was the most tolerant strain, followed by the Japanese race "Kou" and "J-09"; and the Chinese rece "C-54" was the most susceptible strain. The cocoon shell weight percentages were found to be not significantly different among treatments in polyvoltine strains, but different in bivoltine strains. A reduction in silk yields was found in the treatment of the high and fluctuated temperatures.

BIOLOGY AND CONTROL OF PEAR PHYLLOXERA "*APHANOSTIGMA JAKUSUIENSIS* (KISHIDA, 1924)" IN TAIWAN, CHINA. Liu Ta-shiu, Liu Tien-ding (Taichung District Agricultural Improvement Station, Changhwa, Taiwan, China)

Pear phylloxera was first discovered to infest bagged grafting Japanese varietes pear in 1978. However, it breaks out tremendously quick with grafting procedure over growing area. It does parthenogensis, and oviparous year round and takes egg, nymph, and adult stages 9-15, 7-15, and 21-30 days to complete one generation respectively. It lays 47-107 eggs per adult. Its favorite temperature is 24-28°C. Due to its thigmotropism and hiden in every cracks of grafting tape, bag, twig, branch and trunk thus giving difficulty to conact with insecticides. After screening, 80% sulfur D.F. x 800, 60% diazinon F.C. x 1200, and 50% methiocarb W.P. x 1000 could be controlled and make 1 or 2 applications before bagging after grafting and scion should be dipped above mentioned chemical and dilution for few seconds before grafting.

INTEGRATED CONTROL OF PSEUDAULACASPIS PENTAGONA SCALE (DIASPIDIDAE) ON PEACH TREES IN GREECE.

Stergios Paloukis, N. Papadopoulos, Z. Zartaloudis and I. Pitara (Plant protection institute 57001, Thermi, Thessaloniki, Greece).

Pseudaulacaspis pentagona Targ Tozz is a serious pest in Peach orchards in Northern Greece, mainly in those where the constant use of pesticides has destroyed its natural enemies, and particularly the endoparasite *Encarsia berlesei*. The bioecology of the above insects was studied from 1985 to 1990. Samplings were made in 15-das intervals in winter and weekly in spring and summer. One thousand individual scales had been examined per sample. Records were made on the growth stage of the insect, the incidence and the percentage of parasitism. The *P. Pentagona* completes 3 generations per year, the endoparasite *E. Berlesei* 4 generations, with enhanced activity by the end of September. Three years field experiments for controlling the scale revealed that satisfactory results were obtained with spring applications of fenoxycarb 25 WP, buprofezin 25 WP, methidathion 40 WP in doses 70, 50, 140 gr/ 100 lt water respectively. The combination of a spring application of fenoxycarb or buprofezin with an autumn application with paraffine oil (1.5 lt/ 100 lt water) mineral oil on the same dose or potassium oil of fatty acid (11t/ 100 lt water) gave satisfactory results, with the complementary advantage of protecting the endoparasite. The above method could be incorporeted in an integrated pest management system in peach cultivation.

EFFECTS OF ULV APPLICATION OF ORGANOPHOSPHOROUS, CARBAMATE (FICAM) AND DIFLOBENZURON (DIMILIN ODC 45) on Dociostaurs maroccanus (Thunberg) in Khorassan Region of N.E. Iran. S.M.Hosseini[1], S.H. Hodjat[2] & M.B. Shahrokhi, University , Ahwaz & Plant Pest Research Inst. Mashad.

Grasshoppers often outbreak and cause damages to crops in Iran. Khorassan farmers cannot tolerate grasshoppers in their field crops. Iran needs to kill hoppers by, quick action less residual insecticides, to prevent damage to its crops.

Field and laboratory experiments were carried out in Dehcheh Klat (N.E. Khorassan). The number of hoppers were estimated by using a one meter square frames before and after insecticide application. Dimilin was mixed with gasoil, at 1-9 ratio , and other insecticides were diluted in aceton. The insecticides were applied with a spinning disc with nozzles of 1/1mm with a ratio of 2 L/ha on pasture plants, Poa bulbosa and Carex sp. and some broad leaved plants.

Volaton and Fenitrothion application were more effective, and they produced 99.91 percent, and 96.92 precent mortality respectively, in the field experiments. Dimilin produced 94.97 percent mortality after one week of its application. Dursban, Ficam and Hostathion were less effective and produced 91.08-79.90 percent mortality within one week.

A VILLAGE-BASED GRASSHOPPER/LOCUST IPM STRATEGY FOR WEST AFRICA C.R. Edwards (Department of Entomology, Purdue University, West Lafayette, IN 47907-1158, USA) and E.W. Huddleston (Department of Botany and Entomology, New Mexico State University, Las Cruces, NM 88003, USA)

There are two approaches to grasshopper/locust control, Crisis Pest Management (CPM) and Integrated Pest Management (IPM). The 1986 Senegal/Gambia grasshopper control program is a classic example of CPM. Grasshopper populations, which had been increasing for several years prior to 1986, reached critical levels in 1986 prompting the implementation of a large scale control program costing millions of dollars. As is often the case in a CPM program, much of the spraying was done after the crops had already been destroyed and/or grasshopper populations were on the decline. To counter the need for future grasshopper/locust CPM programs, a village-based IPM strategy was developed. This village-based approach utilizes local farmers, farm wives, youth, etc., to monitor grasshopper/locust development and population densities. These individuals, termed scouts, have the most to gain from careful, accurate monitoring and timely reporting of pest activity. A special feature of utilizing local people is that there is peer pressure for accurate, reliable scouting and reporting. Costs of scouting by locals are a small fraction of government employees operating as scouts. In a model program, grasshopper/locust scouting would begin at the start of the rainy season and continue until near harvest.

LOSSES ASSESMENT OF FORAGE YIELD CAUSED BY THE GRASSHOPPER CHORTHIPPUS DUBIUS (ZUB.) ON RANGELAND IN INNER MONGOLIA OF CHINA. Hong-chang Li & Wei-min Fan (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The experiment of this paper was carried out on the steppe of Inner Mongolia. It indicated the following 4 items: (1) Sampling sites for observing the population of grasshopper were set up on grazing pasture with an area of one ha, 20 plots were sampled by a sampler ($1M^2$) from the first ten days of May to second ten days of Oct. in each year of 1988-1990. (2) The quantity of food consumption by grasshopper was determined by hanging cages in field. And the results indicated: the mean quantity of consumption reared with A. chinense by each individual was $\overline{W}$=0.5019(g.dry) in male, $\overline{W}$=0.7390 in female, for both nymph & adult stages. (3) The correlation between quantity cut-off lossed & population density of grasshopper as observed in three years of 1988-1990 was expressed by, (a) the linear regression equation in its nymph stage, (b) the logrithermic curve in its adult stage. And the mean accumulation quantity of forage cut off losses by each individual in its life history was calculated as $\overline{W}$=0.4372 in male and $\overline{W}$=0.5470 in female. (4) The general forage losses can be calculated by a formula: $Y = \frac{-252.8+625.6d}{1-\exp(6.458-0.1065t)}$, Where, t=the time hatching began, d=population density of the grasshopper at time of t.

EFFICACY OF NEEM, *AZADIRACHTA INDICA* A. JUSS, IN CONTROLLING THE LABORTORY AND FIELD CAPTURED LARVAE OF *SCHISTOCERCA GREGARIA* FORSKAL IN FIELD TRIALS IN NIGER. O.M. Nasseh (Gesellschaft fur Technische Zusammenarbeit/GTZ, Germany), H. Wilps (Institut of Zoology, Freiburg, FRG), G. Salissou (Plant Prot. Division, Niamey/Niger)

Neem, *Azadirachta Indica* A. Juss, is an important evergreen tree which is planted along avenues and roads in Niger. Neem grows widely under divers ecological conditions in the country. In continuation of the GTZ Desert Locust research project, commercial preparations of neem oil were tested. The products were evaluated for their effect as botanical pesticides against the laboratory reared and field captured larvae of *Schistocerca gregaria* FORSKAL on *Schouwia thebaica* WEBB plant. The topical application of neem oil was carried out with an ULV sprayer, Micro-Ulva, at a rate of 500ml and 1000ml/ha. All formulation of Azal-F and unpurified oil, were tested in large cages in the field, against 3rd-5th-instar larvae of the Desert locust. Larval and adult survival, retard development, deformation and mortality served as the criteria of evaluation and were recorded at daily intervals after spraying. There was no statistical difference between Azal-F and unpurified oil at 1 l/ha. Both formulation found to control significantly the larvae through either direct kill or interference with metamorphosis, leading to malformation and 100% death.

A PRELIMINARY STUDY ON THE DYNAMICS AND DAMAGED SYMPTOMS OF DOMINANT COTTON SPIDER MITES IN XIN XIANG COUNTY, HENAN PROVINCE IN CHINA. Yu Cao(Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094,China)

The dynamics of the dominant cotton spider mites were investigated by using the slide-squash technique and counting the numbers of the spider mites on the leaves. Results indicated that the population of the cotton spider mites was a complex one, composed of Tetranychus cinnabarinus and T. truncatus, in Xin Xiang County. The dynamics of the dominant species varied with years and different periods in a year. T. cinnabarinus was dominant in 1986. During the early stage of cotton growth in 1987, T. cinnabarinus was also dominant; but to early July, T. truncatus increased to be a dominant species which maintained its dominance to late stage of cotton growth. Symptoms due to the damage by these two species were studied preliminarily in 1989 and 1991. It seems that the red leaves were caused by T. cinnabarinus, and leaves with white-yellow spots were by T. truncatus.

COTTON BOLLWORMS MANAGEMENT WITH INSECTICIDES IN INDIA : RETROSPECT AND PROSPECTS. VASANT L. PATIL, DOWELANCO INDIA, NEW DELHI - 110 065,INDIA

Cotton is an important cash crop in India which accounts for > 50% of total insecticides consumption. Most of these are used to control bollworms viz. Earias vittella, Helicoverpa armigera and Pectinophora gossypiella. The introduction of pyrethroids in early eighties revolutionised the bollworm control and due to farmers overdependence on pyrethroids especially in South India, resulted in development of resistance to pyrethroids. This trend can be reversed with need based or judicious use of currently available conventional insecticides like chlorpyrifos, quinalphos, endosulfan and monocrotophos.

Two years dosage-response trials under field conditions (1989-90 and 1990-91 seasons) in Tamil Nadu showed that for control of Helicoverpa armigera and Earias vittella chlorpyrifos 400 and 800 g.a.i./ha had maximum boll retention with least boll damage, lowest number of larvae per plant and highest yield of cotton. This was comparable with equivalent g.a.i./ha rates of quinalphos and endosulfan, however, monocrotophos was significantly inferior. Thus, amongst available conventional insecticides, chlorpyrifos >400 g.a.i./ha has better fit for cotton bollworm control in south India.

FRUIT FLY REPRODUCTION CONTROLLED BY ANTIMETABOLITES

Tsiropoulos George ("Demokritos" National Research Center, Athens 15310, Greece)

Dietary administration of antimetabolites, namely, antivitamins and antiaminoacids, effectivelly controlled the reproduction of the olive fruit fly, Dacus oleae, and the walnut husk fly, Rhagoletis completa. From the antivitamins especially effective were the a-picolinic acid, deoxypyridoxine, neopyrithiamine, a-tokopherol quinone, aminopterin, isonicotinic acid and dl-desthiobiotin. From the antiaminoacids effective were:L-canavanine, indole, dl-methionine sulfoxide, dl-p-fluorophenylalanine, dl-phenylalanine.

STUDIES ON INTEGRATED COTTON INSECT PEST MANAGEMENT SYSTEM FOR SINGLE COTTON REGION OF THE YELLOW RIVER VALLEY. Chang-yuan Fang, Fa-qing Hu, Shao-gui Wen, Jing-yuan Xia (Cotton Research Institute, Chinese Academy of Agric. Sci., Anyang, Henan 455112, China)

An Integrated cotton insect Pest Management (IPM) system for single cotton region of the Yellow River Valley was developed based on the serial studies of bio-ecology of major cotton insect pests and their natural enemies, and the principles of systems ecology and systems engineering. The IPM system consists of four major components: technique, information, decision-making and extension, of which the technical part is the backbone and embodies IPM strategy and key tactics. The principle of IPM Strategy is centralizing ecological-regulating mechanism by coordinated applications of cultural, biological and chemical control methods to bring down damage from major pests below their economic injury levels. The key tactics for pest control include habit-regulation, coordination of biological and chemical control, proper application of insecticides, and dynamic decision-making. It has been turned out through implementation that the current IPM system was designed scientifically logical with economic, social and ecological benefits quite significant.

MECHANISM OF CHEMOSTERILIZATION OF DIFLUBENZURON IN THE ARMYWORM, MYTHIMNA SEPARATA (WALKER). Pei Chen, Hui-fen Gong, Jin-zhong Wang, Jian-yun Ding (Beijing Agricultural College, Beijing 102208, China) and Zong-shun Wang (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Diflubenzuron, when fed continuously at a concentration ranging from 0.625 ppm to 10.0 ppm to female adults of M. separata, caused the moths to lay eggs that could not hatch. While female moths were fed continously with this compound at 50 ppm, the development of CA was inhibited, but the fat bodies and ovaries developed as usual, oogenesis seemed to be more or less accelerated. It was found treatment of adults or eggs with diflubenzuron affected the formation of integument and tracheal system of the pharate larvae within the eggs. The epidermal cells became flattened, smaller and without nuclei. The procuticle was very thin or absent. Formation of the tracheal trunks was disrupted. We also found treatment with this compound caused a decrease in the amount of DNA both in the cell nuclei and mitochondria of the embryo. Thus, chemosterilization might result in part from the inhibition of DNA synthesis besides chitin by diflubenzuron.

THE ADVANCE IN THE RESEARCH OF MULTI-SPECIES POPULATIONS ACTION THRESHOLD. Xiao-feng Dai, Yu-yuan Guo (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

In this paper, a review was made on the research situation and perspective of dynamic action threshold of multiple pest species, which is necessary and more practicable for the advanced IPM system, as the focus of attention in IPM has shifted to consider the crop not the simple pest, in recent years, as the management target. The damage mechanism of complex species populations to crop, modelling of compound yield loss evaluation, field experimental technique of complex action threshold, methods of data analysis and treatment, interactions among multiple pest species, and compensation capability of crop were discussed.

ERADICATION OF QUEENSLAND FRUIT FLY FROM WESTERN AUSTRALIA

Kingsley Fisher, D. Yeates, A. Sproul, J. Bradshaw (Western Australian Department of Agriculture, Perth, 6151)

An infestation of Queensland Fruit Fly, Bactrocera tryoni (Frogatt), was discovered in Perth, Western Australia, for the first time in February, 1989. The Queensland Fruit Fly was potentially more destructive than the resident Mediterranean Fruit Fly. A programme of sterile insect release, foliage baiting and male annihilation techniques was implemented in September, 1989. In 1991, the programme showed evidence of having eradicated the pest from metropolitan Perth.

Foliage baiting and male-lure blocks were used to reduce the intensity of the infestation while mass rearing facilities were developed. Both techniques ceased as sterile fruit flies were introduced into an area. Sterile fly releases began in January 1990 using a high frequency of low density releases to enhance mature fly availability and to reduce the impact of large releases upon dispersion. 35 million sterile Queensland Fruit Fly per week were released using ground release techniques.

EFFECT OF PLANT LECTINS ON SURVIVAL OF POTATO LEAFHOPPER. Javad Habibi, Elaine A. Backus (Department of Entomology, University of Missouri, Columbia, MO, U.S.A.) and Thomas H. Czapla (Pioneer Hi Bred Int'l Inc., Johnston, IA, U.S.A.)

Fourteen plant lectins with different carbohydrate binding specificity (N-acetylglucosamine and N-acetylgalactosamine) were tested in artificial diets for biological activity against female *Empoasca fabae* (Harris) (Homoptera: Cicadellidae). Artificial diet consisted of 4% agarose, 5% sucrose, and 5 ppm antibiotic. Six of the 14 plant lectins screened caused a significant reduction in leafhopper survival at dietary levels of 0.2% to 1.5% (w/w). The effective lectins were those from *Triticum vulgaris* (WGA), *Artocarpus integrifolia* (Jackfruit), *Pisum sativum* (pea), *Lens culinaris* (lentil), *Phaseolus vulgaris* (red kidney bean), and *Dolichos biflorus* (horse gram). One lectin lengthened insect survival and the other seven had no effect on survival.

PROGRESS TOWARD PESTICIDE-TREATED SPHERES FOR CONTROLLING APPLE MAGGOT FLIES (DIPTERA, TEPHRITIDAE). Jian Jun DUAN and Ronald J. PROKOPY (Department of Entomology, University of Massachusetts, Amherst, MA01003, USA.)

We report on progress in developing a sphere treated with a mixture of pesticide, feeding stimulant and residue-extending agent as a substitute for Tangletrap^{R} sticky coating in capturing and controlling apple maggot flies, *Rhagoletis pomonella* (Walsh). A mixture containing corn syrup, dimethoate or methomyl, and a polymer thickener killed more than 70% of *R. pomonella* alighting on treated spheres at 0 residual days but became nearly ineffective after treated spheres were exposed to weather for 21 days, during which the commulative rainfall was over 75 mm. Retreating aged spheres with 10% sucrose, however, resulted in restoration of fly mortality to a level equivalent to that of a freshly (0-day) treated sphere. At a concentration of insecticide equal to 5 times the LC90 rate, pesticide-treated sphere effectiveness in killing *R. pomonella* was found to be strongly dependent upon presence of a feeding stimulant, as the stimulant elicits fly consumption of a lethal dose of toxicant during the short period (10 minutus or less) during which a fly remains on a treated sphere.

THE EFFECT OF GOSSYPOL THROUGH FOOD CHAIN ON THE PARASITISM AND DEVELOPMENT OF CAMPOLETIS CHLORIDEAE (UCHIDA) IN COTTON BOLLWORM. Chen-zhu Wang, Qi-hua Yang, Ning-tsang Cheo (Department of Plant Protection, Beijing Agricultural University, Beijing 100094,China)

The effect of gossypol, an important secondary chemical in cotton with strong insect suppression activity, by way of cotton bollworm Heliothis armigera (Hübner) indirectly on the parasitism and development of Campoletis chlorideae (Uchida), one of the main parasites of cotton bollworm in Huanghe River Valley, were studied. The growth of host was accelerated by adding 0.1% gossypol in the synthetic diet, causing 10.75% reduce of the suitable parasitic period; while the suppression activity of 0.5% gossypol to the host prolonged the suitable parasitic period by 28.15%. There was negative effect of gossypol on the development of this parasite, the stimulation to the growth of host in low gossypol concentration treatment did not increase the body weight of adult wasp, but significantly extended the egg and larval stages and shortened the pupal stage; the suppression effects of high gossypol concentration on the reduce of body weight and lifespan of adult wasp and pupal stage, and increase of egg and larval stages were more significant. Finally, the coordinate application of insect resistance of cotton and biological control in cotton IPM was discussed.

IDENTIFICATION OF CERTAIN SEMIOCHEMICALS AND INSECT DEVELOPMENT INHIBITORS FROM CERTAIN PLANTS OF ANDHRA PRADESH (INDIA) FOR INSECT PEST MANAGEMENT

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Use of semiochemicals and insect development inhibitors of plant origin are gaining importance because they donot create problems like those of conventional pesticides. We have collected stem, leaf,fruit and flower parts of many wild forest plants available in Andhra Pradesh and extracted the phytochemicals. They have shown phagodetterency against Spodoptera litura and Heliothis armigera. Oviposition detterency and attractancey against Anopheles stephensii and Dysdercus similis. Certain phytochemicals acted as effective IDI by interfering with larval growth and duration, moulting, metamorphosis and fecundity and fertility associated with alterations in gonads, when freshly moulted fifth instars of D.similis were treated. These resulted in the formation of super nymphs, adultoids and normal adults. In males alterations in size and shape of testis, vas deferentia, acessory glands due to changes in spermiogenesis and the related phenomena. In females underdeveloped ovarioles, oosorption compound egg chamber formation and presence of few developed oocytes are common due to the effect of oogenesis. Similar results were obtained when 1. Treated males and untreated females and vice-versa. 2.Both the insects were treated. The related histological, histocemical and biochemical studies were made. All these were dosage and compound specific. The activity was as follows stem > Fruits > leaf > Flower.

MOTH CATCHES BY PHEROMONE TRAPS IN RELATION TO METEOROLOGICAL CONDITIONS. L.KHAN and D.P.GUPTA.Department of Zoology, University of Sagar, SAGAR 470003 (M.P.) INDIA.

Observations on pheromone traps were recorded from September 3, 1986 to March 4, 1987 on three bollworm pests viz., American bollworm, (Heliothis armigera, Hubner) spotted bollworm, (Earias vitella, Febricious) and Pink bollworm (Pectinophora gossypiella, Saunder). American bollworm and spotted bollworm were found active throughout the course of observations, whereas Pink bollworm had quite low and irregular activity. Heliothis armigera and Earias vitella moth catches showed positive and significant correlation with minimum temperature and relative significant correlation with minimum temperature and relative humidity. Moth catches of Earias vitella had positive and signficant correlation with maximum temperature. Whereas moth catches of Pectinophora gossypiella did not show significant correlation with the maximum, minimum temperature and relative humidity.

Monitoring Field Population of The European Sunflower Moth, Homoeosoma nebulella (Den. & Schiff.) (Lepidoptera: Pyralidae) With Its Sex Pheromone. PERMANA Agus D., S. SASTRODIHARDJO (Inter University Center Life Sciences-ITB, Ganesha 10 Bandung 40132 Indonesia)., F. LECLANT., Y. PIVOT (Laboratory of Zoology ENSA/INRA, 2 Place Pierre Viala, 34060 Montpellier France).

The European Sunflower Moth (ESM), Homoeosoma nebulella constitutes the higher potential risk among pest insects damaging sunflower crops. This oligophagous moth exlusively attacks Compositae. The present research was carried out on field studies of sex pheromone of this moth. Various pheromone compounds was tested and pheromone traps refined to determine the distribution of the pest and its flight periods, notably the onset of the flight which allows for the estimation of the risk periods. The traps were placed in a line at the border of the cultivated sunflower plot. Six formulations was tested in 1988, 14 in 1989 and one in 1990. Four components was isolated; (Z)-11-hexadecenal (49.5%), (Z)-13-octadecenal (37.1%), (Z)-9-tetradecenal (8.6%) and (Z,E)-9,12-tetradecadienal (4.8%). The minor component of the pheromone mixture is essenfdtial to attract the males of ESM.

FLIGHT ACTIVITY AND TAKE-OFF BEHAVIOUR OF *CHILO PARTELLUS*. Peeter Päts (Swedish University of Agricultural Sciences, Department of Plant and Forest Protection, Box 7044, S-750 07 Uppsala, Sweden)

The diurnal flight periodicity of the nocturnal moth *Chilo partellus* (Swinhoe) was measured in the laboratory using an actograph and in the field using suction traps and night goggles. Females showed almost no flight activity on the eclosion night. Take-off by mated females occurred soon after sundown and flight activity peaked before midnight, which concurred with oviposition. Peak male activity occurred after midnight coinciding with female eclosion. Males were active for longer periods than females. Female calling behaviour and mating were observed in the field. Data on flight activity, take-off and reproductive behaviour are discussed in relation to plant protection in maize.

TRADITIONAL CROP PROTECTION AND INTENSIFIED SUBSISTENCE AGRICULTURE IN KENYA, EAST AFRICA. Schaefers, George A. Rockefeller Foundation Environmental Agriculture Fellow, New York State Agricultural Experiment Station, Cornell University, 14456-0462, Geneva, N.Y., U. S.A.

Pest management is an integral and crucial associated management system if essential production increases are to accommodate human population expansion in East Africa. The reasons for the failure to successfully transfer western IPM technology to the third world countries are now recognized. Clearly, IPM programs, suited to a necessarily intensified subsistence agriculture must be developed in-place with a sound traditional knowledge base including an understanding of not only the local ecology but socio-economic factors as well.

The study attempts to identify and assess the traditional protection tactics utilized by small farmers in sub-saharan East Africa during crop production as well as post-harvest storage. Methodology includes an extensive search of the literature with emphasis on numerous unpublished reports as well as detailed reviews of several on-farm crop protection surveys conducted throughout Kenya. Tactics found to be of practical value will be evaluated in terms of todays' environmental and health constraints, and where appropriate will be selected as a foundation upon which more modern IPM technologies can be sequentially added.

This study, supported by the Rockefeller Foundation, was conducted in collaboration with the Crop Protection Research Unit and The Social Science Interface Unit at the International Centre of Insect Physiology and Ecology, in Nairobi, Kenya.

BREEDING FOR RESISTANCE TO INSECT PESTS AT PIONEER HI-BRED INT. INC. John E. Campbell, Pioneer Hi-Bred Int. Inc., P.O. Box 85, Johnston, IA 50131 U.S.A.

Pioneer was founded in 1926 to apply newly discovered genetic techniques to hybridize corn. Today, the company develops, produces and markets, proprietary hybrids of corn (Zea mays L.), sorghum (Sorghum vulgare Pers.), sunflower (Helianthus annus L.), and varieties of soybeans (Glycine max L.), alfalfa (Medicago sativa L.), and soft red winter wheat (Triticum aestivum L.). Other current research includes the development of canola (Brassica napus), an oilseed crop.

Genetic differences exist for many important agronomic traits including plant pathogens and insect pests. Historically greater breeding emphasis has been placed on plant resistance to pathogens than insects. This is primarily because chemicals that will economically control plant pathogens are not generally available.

Attempts at breeding for resistance to insect pests has met with variable success. In some crops such as wheat breeding for resistance to Hessian fly (Mayetiola destructor Say) has provided the primary means of control. In other cases such as the corn rootworm complex, Diabrotica sp. in corn, considerable effort has been expended yet no useful antibiosis type resistance has been found.

The success of breeding for insect resistance in the various crops marketed by Pioneer will be discussed.

Preliminary investigation on the enemies of slugs and snails pests in Northern IRAN. Salehi Latif (College of Agriculture University of Guilan, P.O. Box 41335-3179, Rasht-Iran & Kharrazi Pakdel.A. (College of Agriculture, Theran University, Karas IRAN).

From the year 1989 we started the investigation on predatures and parasites of Mollusca pest at Guilan province. Every year, the slugs and snails gave much damages, in Northern IRAN. Our study was of two parts: 1-Identification of host plants for this pest; and, 2-Getting to know about their natural enemies. The procedure include: Collection of snails and slugs from the different parts of Guilan during their months of activity. Growing them in the laboratory for investigation of their hosts and collection of their predature bittle, with two methods of netting in the farm and use of light trap. In this study some predatures and parasites were found as follows: 1-Three species bittles from the silphidae, Lampyridae and carabidae families, 2-Two species fly parasites from sciomyzidae and sarcophayidae families.

STUDIES ON THE SUSCEPTIBILITY OF TWELVE INSECTS TO THE MICROSPORIDIUM VAIRIMORPHA PLODIAE. Liwang Cui, S. U. Rybina (All-Union Institute of Biological Methods in Plant Protection, Prospect Mira 58, Kishinev 277072, Moldova)

In our experiments, ten of twelve tested insects were susceptible to the microsporidium, Vairimorpha plodiae, i. e., Heliothis armigera HB., H. dipsacea (L.) Mamestra brassicae L., Agrotis segetum Schiff., Antheraea pernyi Guer., Carpocapsa pomonella L., Loxostege sticticalis (L.), Lymantria dispar L., Stilpnotia salicis (L.), and Hyphantria cunea (Drury). In infected hosts, the fat body was the only tissue where microsporidian spores were found. The symptoms of infection were also described. The prospective utilization of this microsporidium as an agent for microbial control of noctuid pests was discussed.

DEVELOPMENT OF SYSTEMS APPROACHES FOR INSURING QUARANTINE SECURITY OF AGRICULTURAL COMMODITIES. Eric B. Jang (USDA-ARS, Tropical Fruit and Vegetable Research Laboratory, P. O. Box 4459, Hilo, Hawaii 96720, USA)

The development of systems approaches for insuring quarantine security of agricultural commodities integrate biological, physical, and operational factors which can affect the incidence, viability and reproductive potential of a pest into a system of practices and procedures which cummulatively provide quarantine security. Field production practices aimed at controlling pest infestation levels and preharvest selection procedures can reduce infestation in harvested commodities. Further postharvest practices targeted at removing pests can include a direct treatment as well as various inspection procedures. Consideration of marketing and distribution of commodities may further reduce the risk associated with pest introduction. Identification of allowable infestation levels at each step of the system allows one to quantitate specific limits necessary for subsequent practices to be implemented.

BIOCHEMICAL BASIS OF RESISTANCE TO INSECT PESTS IN CULTIVATED & WILD GROUNDNUT SPECIES. F M Kimmins, P C Stevenson, D E Padgham (Crop Resistance Mechanisms Group, Natural Resources Institute, Chatham, Kent, ME4 4TB UK), R J Grayer (Department of Plant Sciences, University of Reading, Whiteknights, PO Box 217, Reading, RG6 2AH).

Cultivated groundnuts (Arachis hypogaea L) provide an important source of protein and oil in semi-arid regions but indirect and direct damage caused by insects such as aphids and lepidopteran larvae can impose a severe constraint on production. Integrated pest management strategies including host plant resistance are currently being investigated in a collaborative project between the International Crops Research Institute for the Semi-Arid Tropics, India and NRI, UK. A negative correlation between aphid resistance and the condensed tannin (procyanidin), concentration of cultivated groundnut genotypes has been established and is being used in screening for aphid resistance. Chemical resistance in wild Arachis to Spodoptera litura involves compounds similar in structure and activity to chlorogenic acid. Their potential for incorporation into cultivated genotypes is being evaluated.

FORAGING ACTIVITIES OF WASPS AND THEIR USEFULNESS IN PEST CONTROL. Prince E. Sosu & Francis M. Sosu (FES. Beekeeping Promotion Centre, Accra-Ghana, West Africa)

Beekeeping development projects encourage afforestation and reforestation and discourage chemical spraying. Beekeeping-industry, therefore, addresses the nation-wide environmental degradation and promote ecologically sustainable development in the tropical and subtropical countries. These countries, being agricultural production areas and full of crop pests, there is need for the above researches to control these pests naturally. Our research findings is to address the basic equation of development i.e. man and nature.

THE INFLUENCE OF TWO FARM MANAGEMENT SYSTEMS ON COLEOPTERA POPULATIONS. M.K.Giri (Zoology Department Tribhuvan University, Kirtipur, Kathmandu, Nepal)

Carabids and Staphylinids are two important abundant groups of coleoptera in the cereal fields. The increase and decrease of their populations have direct effect on the cereal pests in the field. Therefore, it was attempted to see whether there is any difference in Conventional (frequent use of pesticide and Integrated (use when necessary) farm management systems by sampling Coleoptera populations using two methods, Pitfall traps and Quadrats. The results indicated the former field had more diverse populations as well as diverse vegetations than the latter, but the latter had more individuals than the former field.

PRELIMINARY STUDY ON SEVERAL SOYBEAN GENOTYPES RESISTANCE TO SOYBEAN POD BORER, Legyminivora glycinivorella Matsumura. De-rong Yue, Jian-ping Li, Gui-hua Yang, Rong Zhang and Yun-sheng Wang (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Gongzhuling 136100, China)

Studies was conducted with eight resistant and susceptible soybean genotypes under artificial infestation condition. The results show that the pod of soybean is a important factor affecting soybean resistance to soybean pod borer. Maybe the adults and larvae don't choose Mao Jia Huang to egg and feed. Having bored into the pod, the mortality of the larvae is evidently higher for before feeding than after feeding on Huai De Mao Yan Dou. The silica content of the pod is positively correlated with the mortality of the larvae when the larvae bore into the pod, but not significantly correlated with the hardness of the pod.

Soybean resistance to soybean pod borer not only display having low injured seed percentage but also delay growth and development of the larvae and lose the weight of the larvae. The weight and mature percentage of the larvae feeding susceptible genotypes is significantly higher than that of the larvae feeding resistant genotypes in the test.

BIOLOGY AND ECONOMIC IMPORTANCE OF WHEAT STEM SAWFLY (*CEPHUS PYGMAEUS* L.) IN IRAN. Parvaneh Azmayesh Fard (Entomology Department, Faculty of Agriculture, Tehran University, Karaj 31584, Iran).

Cephus pygmaeus L. is a potential pest in certain wheat growing areas, such as Karaj, Varamin, Qazvin, Esfahan, Zanjan, Hamadan and certain other places of Iran. The larvae feed on stem tissues, developmental cycle such as incubation period, development and diapausing of larvae, putation period and longevity of adult are investigated under Karaj climatic conditions. *Elachertus proteoterat* (Hym - Eulophidae) was observed to parasitized 25.8% of larvae. Use of resistant cultivars for is one of the best way to prevent damage of this insect, experiments were carried on ten varieties of wheat cultivars for three years and degrees of resistance is investigated.

LEAF MINERS (AGROMYZIDAE, DIPTERA) ON POACEAE IN SERBIA (Yugoslavia). Radoslava Spasić (Faculty of Agriculture, University of Belgrade, 11081 Belgrade-Zemun, Nemanjina 6, Yugoslavia)

Agromyzid species as pests of cultivated cereals in Serbia (Yu), are given in this paper. Also, these results includes the investigation of agromizid fauna on different grasses from Poaceae, which can possible use for keeping a populations of these insects.
Agromyzid material was collected in several localitiesof Serbia from cultivated cereals fields and out of them, by sweeping net and rearing from mines in the laboratory.
Established species are from the genera Agromyza, Pseudonapomyza, Cerodontha and Chromatomyia.
The great number of identified species on Poaceae belong to Agromyza genus.

INVESTIGATIONS ON DENSITY DEPENDENT RESPONSES OF SYRPHIDS (DIPTERA: SYRPHIDAE) IN WINTER WHEAT. Brigitte Tenhumberg, Hans-Michael Poehling (University of Göttingen, Institut for Plant Pathology, Department of Entomology, Grisebachstraße 6, D-3400 Göttingen-Weende, FRG)

From 1988 to 1990 field trials in winter wheat with different levels of aphid infestation were conducted in Lower Saxony (FRG). The species composition of the syrphids consisted of *Eupeodes corollae* (FABR.), *Melanostoma mellinum* (L.), *Eupeodes lundbecki* (SOOT-RYEN), *Scaeva pyrastri* (L.) and *Sphaerophoria scripta* (L.) and the predominating species *Episyrphus balteatus* (DEG.). The syrphids responded in two ways on varying aphid abundance: 1. They showed a positive density dependent egglaying behaviour i.e. a numerical response. 2. A higher density of aphids resulted in higher weights of larvae and pupae indicating an increased feeding activity i.e. a functional response. Thereby only the survival rate of starving larvae was reduced by decreasing food supply. In some years parasitization was the main mortality factor. Although the observed density dependent reaktion predestinate the syrphids to control the aphids, they play a major role as a biological control agents only in years of good predator-prey synchronisation between aphids and predators.

INSECT PEST MANAGEMENT AND ITS FUTURE IN INDIAN MAIZE PROGRAMME. L.M.L. Mathur (Indian Agricultural Research Institute, New Delhi - 110 012, India)

In India, maize is attacked by over 250 insect and mite species under field and storage conditions. A dozen of these species pose serious threat in the intensification of maize cultivation. Among these, the stalk borer, *Chilo partellus* (Swinhoe) alone causes damage to the extent of 20-87% to the standing crop under varying agroclimatic conditions. Thus the lower limit of avoidable loss is estimated at Rs. 3646 millon annually.

Current studies reveal that (a) about 36% of the hibernation larvae reach adulthood during middle of March and their populations reach at peaks in mid-May and mid-June, (b) *Trichogramma* sp., *Apantales* sp. and *Xanthopimpla* sp. constitute potential biotic agents for eggs, larva and pupa respectively, which effectively reduce natural borer populations, (c) 10-17 day old plant is highly vulnerable to borer attack and a minimum of 5 larvae is sufficient to kill a healthy plant, (d) two sprays of endosulfan or one application of carbofuran granules constitute prophylactic treatments to protect the crop from borer damage and (e) cultivation of less susceptible cultivars give higher monetary returns to the maize growers. Consistent efforts are being made to isolate borer resistant genotypes and to identify genes on related chromosomes responsible for such resistance and ultimately to exploit these genes for breeding borer resistant varieties. Efforts are being made to utilise the data for the development of integrated pest management program.

LABORATORY AND FIELD EBALUATION OF INSECTICIDES AGAINST THE CASSIDA NOBILIS L. (CHRYSOMELIDAE) A SERIOUS PEST OF SUGAR BEET. Philipos m. Ioannidis Plant Protection service and research, Hellenic Sugar Industry Platy- Imathias 59032, GREECE.

Cassida nobilis is considered a serious pest on sugarbeet in some areas in Greece since 1982. The insect overwinter as adult with 2-3 generations per year. The tortoise beetle attacks also on weed hosts belonging to Chenopodiaceae (chenopodium album) and Cruciferae. The main reason for the spread of the pest was that the extensive use of the herbicides has as result the destruction of the weeds in very early stages, therefore most of the overwintering emerged pest concentrates on the young sugarbeets. The economic threshhold for starting foliage sprays is considered 2-3 larvae/m2. Bioassays by topical applications of 0.5 µl droplet of solution per insect and extensive field screening of more than 20 insecticides for three years were conducted. The most effective and recommended formulated products at larvae stage for field use, were the Triazophos (40%) at 0.8 Kg/Ha, carbofuran (35%) at 0.8 Kg/Ha Azinphosmethyl (40%) 1 Kg /Ha, Cypermethrin (10%) at 0.3 KG/Ha. To find the proper field doses and to compare results among the insecticides, three dose-level of each insecticide had been used 0.5, 1, 2 Kg /Ha for organophospnates and carbamates and 0.15, 0.3, 0.6 Kg/Ha for pyrethroids.

DELIA PLATURA (MEIGEN) AS A SOYBEAN INSECT PEST. Kim, Tae Heung, (Department of Agricultural Biology, Chonbuk National University, 560-756, Republic of Korea)

The seedcorn maggot, *Delia platura* (Meigen), is a world-wide insect pest attacking crop seeds during germination and at the same time dispersing pathogens that cause root-rots. Soybean is no exception in terms of being attacked by this pest and the end result of the attack is expressed as a direct and indirect influences on the productivity of soybeans at harvest.

Early, mid, and late maturing soybean varieties were artificially infested with the maggot at seeding and emerging seedlings were marked for five damage levels(0, 25, 50, 75, and 100% of the first unifolioate leaves). When the pair of first unifolioate leaves were slighlly damaged(25%) by the maggot, no significant reduction in plant dry weight and yield was observed at harvest regardless of the varieties. However, the reduction became evident in plants which had received more than 75% loss of unifolioate leaves. Mid and late maturing varieties with similar level of leaf damage had approximately the same degree of reduction in yield.

CORN SOIL INSECT PEST MANAGEMENT IN ILLINOIS.
K. Steffey, H. Oloumi-Sadeghi & M. Gray (Agricultural Entomology, 172 Natural Resources Building, Champaign, IL 61820 USA)

Control of soil-inhabiting insects is one of the most expensive components of corn insect management in the north central United States. The primary soil insect pests in Illinois are corn rootworms (*Diabrotica virgifera virgifera* and *D. barberi*), black cutworm (*Agrotis ispsilon*), wireworms (several species), and white grubs (*Phyllophaga* spp.). Our Corn Insect Research/Extension team studies many aspects of corn soil insect management. In addition to insecticide efficacy trials, we have investigated many other aspects of soil insect management: behavior of soil insecticides in different environments, effect of insecticides on insect behavior, efficacy of nematodes against key soil insect pests, ability of corn plants to compensate for insect injury, interactions of insecticides and sulfonylurea herbicides, sampling methodology, and development of reliable experimental and evaluation techniques. We have also involved many cooperating farmers in our studies, e.g., an extensive on-farm research program to determine the effects of reduced insecticide application rates for corn rootworm control and a network of cooperators to monitor spring flights of black cutworm moths. Our team-research approach allows us to gather critical information that is conveyed almost immediately to Illinois farmers for their implementation into IPM programs.

A PATH ANALYSIS FOR DAMAGES CAUSED BY THE ASIAN CORN BORER OSTRINIA FURNACALIS (GUENEE) TO CORN. Li-ping Wen, Da-rong Zhou (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

The relationship between damages caused by different generation Asian corn borer, Ostrinia furnacalis (Guenée),(ACB) and corn yield losses was tested and pathly analyzed on two single-crosses(SC)--Zhongyuandan-4(Resistant) and Zhongdan-2(Susceptible) in Beijing from 1988 to 1990. The grain yield was as a dependent variable(y) and the leaf-feeding ratings. holes/100plants, ear length and 100-grain weight as the independent variables(X_1, X_2,X_3 and X_4). The results showed: a)The direct path coefficients of the hole number(X_2) caused by the ACB to yield(y) were significantly larger than those of the other independent variables on the two SCs infested by the first and second generation larvae, which were -0.78394**, -0.65554** and -0.63069**, -0.79264*,respectively, indicating that the yield loss of corn was mainly due to stalk damage(represented by holes/100plants). b)The direct effects of leaf-feeding damage(X_1), ear length(X_3) and 100-grain weight(X_4) on yield(y) were related to the damaging generation of ACB and the resistance of SCs. c)The indirect effect of leaf-feeding damage(X_1) of the first generation ACB on yield(y)through stalk damage(X_2) was larger than its direct effect because more leaf-feeding damage in the early stage of plant development resulting into more late-instar larvae tunneling the stalks in the late stage. d)Stalk damages caused by the first generation ACB mainly influenced the ear development and those of the second generation--the filling of seeds.

#1

PRIMARY DISCUSSION ON THE SUCCESSIVE CHARACTER OF THE INSECT FAUNA OF XIZANG. Baohai Wang, Weihong Yuan (Tibet Institute of Agricultural Sciences, Lhasa 850002, China)

The Tibet plateau is known as the roof of the world, it consists of the Eurasia continent and South Asia subcontinent. The form of the primitive continents are older than Tibet plateau, so the insect fauna of Tibet has the primitive species of this two primitive continents. However, it has been developing a great deal of new lives and is promoting many new species and genus arising in the course of sudden ascent of the Tibet plateau. The insect fauna of Tibet has also contact with other continents from analysing of the insect fauna. The center of the plateau belongs to the paleartic region, but the endemic and alpine species occupy obviously an important place. The himalaya tropical rainforest and the monsoon forest belong to the oriental region.

#2

STUDY ON THE PREFERENCE OF COCCINELLA SEPTEMPUNCTATA LINNAEUS BETWEEN TWO SPECIES OF WHEAT APHIDS. Xiao-ming Cai, Gui-yun Yan (Department of Biology, Beijing University, Beijing 100871, China)

The preference of Coccinella septempunctata Linnaeus between English grain aphid Macrosiphum avenae (Fabricius) and oat bird-cherry aphid Rhopalosiphum padi (Linnaeus) was studied in laboratory. The results showed that: 1. The predator has a obvious preference of M. avenae to R. padi. 2. The preference of this ladybird significantly increased with the density of R. padi, while significantly decreased with the increase of M. avenae density. 3. The functional response of the predator to mixed population of the two aphid species tends to Holling's III type, and its typicality increase with the stable increase of aphid population. 4. The effect of the increase of R. padi density is more evident than that of M. avenae on the reduction of the predation of C. septempunctata.

#4

BIONOMICS OF THE ALLIUM LEAFMINER, *Acrolepiopsis sapporensis* (LEPIDOPTERA : ACROLEPIIDAE), IN CHONBUK PROVINCE, KOREA. Chang - yeon Hwang, Jai - ho Chong (College of Agriculture, Chonbuk National University, Chonju 560-756, Korea)

Studies were carried out to investigate the bionomics of the allium leafminer, *Acrolepiopsis sapporensis*, in Chunbuk province in 1990 - 1991. Longevity of the female was 18.3 days which laid an average of 172.2 eggs at 20°C. Embryogenesis took 7.7, 6.0, 3.4 and 3.0 days at 15°C, 20°C, 25°C and 30°C, respectively. Larval stadia were 19.9, 14.0, 10.0 and 9.7 days on scallion leaves at the similar condition described above. Pupal periods were 12.2, 8.6 and 6.9 days at 15°C, 20°C and 25°C, respectively but adults failed to emerge at 30°C. One complete generation required 39.9, 28.8 and 20.7 days. The adults showed distinct ovipositional host preference the order of onion > scallion > garlic > chive. Larvae grew on onion, scallion and garlic but did not grow on chive.

#5

SYSTEMATIC MANAGEMENT ON TIBET PLATEAU AGRICULTURAL INSECTS. Gangxi Zhang (Plant Protection and Quarantine Station of Tibet, Lhasa 850000, China), Shulin Li (Forestry Expedition and Research Institute of Tibet, Lhasa 850000, China)

Primarly statistic records of 367 species of insects are harmful in agriculture. Among Them 198 are harmful of crops. Their distribution, morphology, biology, and adaptation are firmly related with host, climate, topography, altitute and cultivative system. Insects show remarkable plateau feature in fauna. Owing to the land's rising, it exisits "Northern species move to the south". Species special in the plateau are abundant as to make up 35.6% of the total such as Locusta migratoria tibetensis , or Aptinothrips stylifer, etc. Generally speaking, the pests have some characteristice: resonal up and down in population, obviously regional difference both horizontally and vertically, frequent exchanges between natural and manmade system, management system shifted from tradition to modern ways and enlarged damage area of regional pests. The principle of pest management should be to analysis of plateau agricultural ecological system and its surroundings concerned, absorb traditional pest management ways, integratedely use all kinds of suitable measures , or some of them, creat the environment which is good for plant and unfavourable to pests.

#6

ADAPTING IN THE INSECT WING OF TIBET. Weihong Yuan, Baohai Wang, Ping Yu (Tibet Institute of Agricultural Sciences, Lhasa 850002, China)

Under the plateau conditions of Tibet, the adapting evolution of the different insect wings is in the state of imbalance. The adaptability of insect wings is mainly divided into five type:

1. The forewing is complete, but the backwing disappeared.
2. Shortening in the forewing, the backwing still disappeared.
3. The forewing is degenerate, but developed in the backwing.
4. Obviously shortened both of the fore and back wings.
5. Without any wings on the body.

The female wing's degeneration is stronger than the male. The degeneration level is related with sudden ascent of the landforms. The relation of the wing's degeneration and elevation is $Y=0.0775(1.001)^{x}$. The correlation coefficient achieves extremely remarkable level.

#7

PRELIMINARY STUDIES ON THE BIONOMICS AND CONTROL MEASURES OF THE PESTS INFESTING THE DISTILLER'S YEASTS. Shao-you Liu, Jun-xiang Wu, Jian-hua Wei (Department of Plant protection, Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

Based on the preliminary survey in 1988-1989, the pests infesting the distiller's yeasts of 23 species, which belonged to 17 families of 4 orders in Distillery of Hsifeng Chiew, are recorded in this paper. The most predominant species are *Carpophilus hemipterus* L. and *Cryptolestes turcicus* (Grouville). The former happens mainly in the yeast-fermenting rooms. When the wet yeasts are moved into the rooms, the adults migrate and oviposite eggs on them. The average periods of eggs, larvae, pre-pupae and pupae are 1.5, 6.4, 1.3 and 4.7 days in the yeast-fermenting rooms, respectively. The latter happens mainly in the yeast-fermenting rooms and the yeast-fermented stored rooms. The average periods of eggs, larvae and pupae are 6.6, 15.0 and 11.5 days in the avarage 24.1℃ of the natural temperature laboratory. Further more experiment results showed that eliminating the overwinter adults, installing the screen windows and screen doors in the yeast-fermenting rooms and the yeast-fermented stored rooms, using higher temperature of the yeast-fermenting processes, cleaning adults in the peak time of adult emergence, using chemical measures (spraying, fumiganting and treating yeast-chaff) and so on were of good control effects.

#8

A PRELIMINARY STUDY ON THE BIOLOGICAL CHARACTERISTICS AND CONTROL OF AFISSA INSIGNIS (GORHAM). Hong-mou Liu, Shunqing Zhao (Agricultural Bureau of Zhongmou County 451450, Henan Province, China); Ming-zhou Li, Yu-lin Sun, Meng Zhang (Plant Protection and Quarantine Station of Zhengzhou 450000,Henan Province, China)

The morphology, biological characteristics and control of Afissa insignis (Gorham) which injures a chinese drug plant, Trichosanthes kirilowii were studied. This insect pest has two generations per year. The adults overwinter in the crevices of walls, bricks and soil. In the end of April next year, the overwintered adults begin to injure the host plants and lay eggs in the middle 10 days of May. The 1st. generation larvae can be found from the end of May to that of August and the adults may be seen from the last 10 days of July to that of October; the 2nd. generation larvae can be found from the end of July to that of November, and its adults may be found in the first 10 days of August. Owing to the overlapping of its generations, the adults and larvae may be seen in the whole growing season. The adults usually eat off the mesophyll of the host leaves, leaving the epidermis untouched, and their starvation tolerance is very strong.

The effect of using Sumicidin 20 EC or Meothrin 20 EC, a.i 100-200 ppm spraying twice, i.e. once in the fore or middle 10 days of May and once in the middle or last 10days of June is very good.

#9

STRUCTURE AND ACTIVITY OF MAIN TERRICOL ARTROPODA IN SOM. AGROECOCENOSES IN ROMANIA. Victor Ciochia, Daniela Donescu (Academy of Agricultural and Forest Sciences, Lab. Biological Control and Nature Protection, Str. Fundaturii No. 2, RO 2200 Brasov, Romania)

Under the climatic conditions during April-October, comparative research work was carried out on the Artropodae moving on soil. The comparison was made between four agroecosystems in Romania at altitudes 100-578m. In the Artropoda fauna, the captured phytophagous and entomophagous species. The existent relationship between the phytophagous and entomophagous stationary fauna is discussed besides aspects regarding the dominance and abundance of different species. Among them there were evidenced the species of the Coleoptera-Order in proportion over 90%. The role of Carabidae family is emphasized. As for their trophic aspect, from the total of captured species the phytophages ones were dominant, followed by the insects with double trophic regimen (entomophage and phytopage).

#10

A STUDY ON BIOLOGICAL CHARACTER OF STIBAROPUS FORMOSANUS AND ITS CONTROL. Zhuangxing Ma (Shanxi Academy of Agricultural Science, Taiyuan, 030006, China), Sumei Huo (Shanxi antiepidemic station) Linfa Li (Guixi Mouse-killing research Institute)

Stibaropus formosanus (Ish. et Yam) adult is brown colour, ellipse form, body length 4.5-5mm, 10.6-12.9g/1000-head. It will make eggs after mating for 1-1.5 month. The eggs is 1.5mm length, 2.3-2.6g/1000-egg and becomes nymph after 0.5-1 month. The adult will emerge from them after 6 exuviations for 2 months. They exist under ground. They destroy the roots of the crops and make crop yield decrease 20%-70%. The control method: 1. Rotation of leguminous crops or potato crops. 2. Deep-tillage to destroy its existence condition. 3. Application of fertilizer to increase the crop resistance. 4. Chemical control. 5. Integrated control.

#11

REARING AND STERILIZATION OF THE RICE STEM BORER, CHILO SUPPRESSALIS WALKER (LEP. PYRALIDAE). G. Mowlaii and P.Mehrpouian (University of Teheran, Inst. of Abourayhan, P. O. Box 6145, Teheran 14155, Iran).

The rice stem borer, chilo suppressalis walker, is generally considered to be the most serious pest of riee plant in northern provinces of Iran. Chemicals are intensively applied to control of this pest. These chemical methods in addition are being costly, affect the environment, soil and beneficial factors. For investigation of "sterile insect technique" as a possible method for control of rice stem borer, studies were carried in laboratory and rice padies of Amol (Mazandaran province) during the period of 1989 - 1991. On the basis for establishing satisfactory artificial diets for the rearing successive generation of the rice stem borer several formula for preparing diets have been employed. The results showed that antimicrobial agent: Sorbic acid 1% to be the better antimicrobial agent for mass rearing and by substituting the dry riec stem in diets fairly satisfactory results were obtained. Radiation studies by gamma irradiation on the fecundity, fertility and mating behavior following irradiation of 3 - 4 day old pupae revealed that a dose of 200 GY was enough to achieve the complet sterilization in males. No adverse effect was noticed on the vigour and mating behavior of the males at the sterilizing dose.

#12

Radiation Induced Sterility in Ephestia calidella. H.F.Alrubeai; Z.A.Al-gahrbawi and A.A.Al-Taweel. Agri.Res.Dept., Nuclear Res. Cent.P.O.Box 765, Baghdad, Iraq. Last two days old pupae of both sexes of E.calidella were irradiated with 5-40 krad of gamma rays. The influence of each dose was measured on pupal period, adult emergence, longevity mating ability and fecundity. Complete sterility was achived in males and/or females at 40 krad. The dose required to sterilize 50% was 15 krad for males and 10 krad for females. Irradiation of males decreased their mating frequency. No such effect was noticed with irradiated females.

#13

STUDIES ON CONTROL OF SCALE INSECTS BY SPREADING A SLOW-RELEASING PESTICIDE ON STEMS. Ming-li Dong (Weicheng District Station of Plant Protection, Xianyang, Shaanxi 712000, China)

May, having pasted a grain, size of which is between wheat grain and soybean seed, of a slow-releasing pesticide on branch surface of tangerine, where were 16.5cm from its top, the control rate of *Aonidiella aurantii* (Maskell) was 90-100% after 15 days and that of *A. citrina* (Coquillett) was 73.2-84.1% after 45 days. July, when then plants were growing luxuriantly, after having spreaded it on the stems for 7 days, both of control rates as was stated above was 100%. And having spreaded it on branch surface, where were 70cm from the top of oleander for 36 days, the control rate of *Icerya purchasi* Maskell was 100%.

Having spreaded a pesticide band of 10cm wide surround the trund of plane tree whose diameter was 7.8cm, or of 30cm long and wide between 1cm and 1.5cm on branches of *Prunus cerasifera* Ehrh. var. *atropurpurea* Jacq. whose diameters were between 2.5cm and 13cm, where the rough bark was peeled off, both of which could control 100% of *Drosiche corpulenta* Kawana after 5 days.

#14

EFFICACY OF GRANULAR CORN ROOTWORM INSECTICIDES AT REDUCED APPLICATION RATES IN SOUTH DAKOTA, USA. Mark Boetel, Billy W. Fuller, and David Walgenbach. (Plant Science Department, South Dakota State University, Brookings, South Dakota 57007.

Use of less than the recommended rate was investigated in respect to reducing the amount of pesticide placed into the environment. The use of 75% of the recommended rate for the common granular compounds did not decrease the level of corn rootworm control. In many cases, 50% was found to provide sub-economic control, however failure did occur at this rate with some compounds. Also, we observed a decrease in efficacy using the lowest rates when 7 inch band applications were used compared to the same rate with in-furrow treatments.

#15

PRELIMINARY ANALYSIS ON THE CAUSE OF "FIVE SMALL PESTS" RISING AND ITS CONTROL. Si-min Jin (The Provincial Plant Protection Station of Anhui, Hefei 230031, China)

It is in the first place to crop varieties of pests occurrence, controlling times and amounts of pesticide application to "five small pests" i.e., aphids, mites, wheat midges, thrips and rice planthoppers. Controlling "five small pests" is a key link in the IPM. The causes of five small pests rising are as belows: 1.) Cultivation system changes greatly, multiple crop index and amount of nitrogenous fertilizer are always raised in recent years. It enable ecological condition to be favourable to the pests occurrence. 2.) Wide spectrum insecticides are sprayed solely. 3.) Temperature in winter rises because the global weather evolve. Hence, the region of the pest living through the winter is being expanded and the death rate is lessened. The ways of controlling are included: 1.Expanding variety aera of resistance to the pests, removing weeds and transfer hosts around the field, taking winter and summer ploughing seriously. 2. Selecting pesticide for a special purpose and microbial pesticide. Protecting and utilizing natural enemies effectively. 3.Improving the technique of pesticide application and delaying the periods resistant to pesticides occurrence.

#16

RISK ANALYSES OF JAPANESE CHESTNUT INSECT PESTS TO CHINESE CHESTNUT. Rongfeng Zhang (Agriculture & Forestry Bureau of Shangyu County, Zhejiang 312300, China)

The comparison between over 100 species of japanese chestnut (*Castanea crenata* Sieb. et Zucc.) insect pests and 338 species of chinese chestnut (*C. mollissima* Bl.) insect pests in the distribution, hosts, and destructiveness is presented. Risk analyses in such aspects as destructive degree, possibility to introduce and survive in China, tendency to occur, and the control difficult degree of undistributed main japanese chestnut insect pests in China is covered. Results shows that *Maritziella castaneivora* Miyazaki etc. are more dangerous insect pests, and hereby suggests doing further study to determine if it is necessary to take them for external plant quarantining insect pests.

#17

QUARANTINE PROCEDURE AND ENTOMOLOGICAL INSPECTION OF PANT GERMPLASM AT EMBRAPA/CENARGEN, BRAZIL. M.R.V. de Oliveira, D.N.M. Ferreira (EMBRAPA/CENARGEN, Cx. Postal 02372, CEP: 79840, Brasília, DF, Brazil).

Plant Quarantine has as a basic purpose the prevention of introduction or spread of a pest or disease in new areas. Quarantine plays an important role in germplasm protection in Brazil. The Entomology Laboratory at the Exchange and Quarantine Area of Plant Germplasm (EMBRAPA/CENARGEN) based in these regulatory actions has realized in the second half of 1990 and in the year 1991, 24.916 germplasm inspections. Quarantine examination are realized, regulary, in the imported germplasm, those meant for export and also in our domestic movement. The amount of 66 varieties of plant species were introduced, 59 exported and 58 involved in the internal movement of germplasm. Through these procedures, about 48 species of insects were intercepted and identified. Quarantine must be viewed as one of the most important instruments of envirommental protection, therefore, a considerable effort has been expended to protect the health and prosperity of our domestic agriculture.

#18

EFFECT OF NEEM EXTRACTS ON EGG AND LARVAL SURVIVAL OF SORGHUM SHOOT FLY, *ATHERIGONA SOCCATA* ROND. (DIPTERA: MUSCIDAE). J. O. Zongo (Protection des végétaux, B. P. 403, Bobo-Dioulasso, Burkina Faso, Africa), Charles Vincent (Agriculture Canada Research Station, 430 Boul. Gouin, Saint-Jean-sur-Richelieu, Que. Canada J3B 3E6), Robin K. Stewart (Macdonald Campus of McGill University, 21 111 Lakeshore Road, Ste-Anne de Bellevue, Que., Canada H9X 1C0).

The sorghum shoot fly, *Atherigona soccata* Rond. (Diptera: Muscidae), is a key pest of sorghum in Africa and Asia. The neem tree, *Azadirachta indica* Juss. (Meliaceae), is found in many regions of the world, including West Africa. Sorghum shootfly eggs collected in the field near Matourkou (Burkina Faso) were brought back to the laboratory. The following treatments were applied on the eggs with a micro-pipette: 1) neem oil (0.63 % azadirachtin), 2) 20 g wild neem seeds/L water + adhesol, 3) 30 g wild neem seeds/L water + adhesol, 4) pure local oil (seeds collected near Koudougou) 5) Adhesol 5 ml/ L water and 6) check (water). Neem based products caused significant mortality compared to adhesol and the check. Results from field trial with neem extracts will also be presented.

#19

STUDIES ON THE OCCURRENCE OF SMALL RICE GRASSHOPPER (SRG) IN TAIYUAN. Qiao-ling Zhang, Ke-yi Liu (Agricultural bureau of North suburbs of Taiyuan, 030000, Shanxi, China), Bao-ming Wang (Institute of Horticulture, Shanxi academy of agriculture, Taiyuan, 030000, China)

The SRG, Oxya chinensis Thunberg, occurs 1 generation per year in Taiyuan, and overwinters as eggs. When ≥10°C, and the cumulative temperature (CT) ≈350 day°, the nymphs hatched. Their occurrence showed a longer duration (late May to late Sept.). When ≥10°C, and the CT ≈570 day °, the nymphal occurrence entered first peak phase (324-393 individuals/m2). On July 15-20, to a second peak phase (127-129 individuals/m2). The results of correlation analysis indicated that, there was significant positive correlation between the nymphal occurrence from initial to first peak phase and the CT (r89=0.992**, r90=0.991**). A comprehensive analysis for the data of two years shows that, the relationship between the first peak phase of SRG's occurrence and the CT≥ 10°C, is coincided with mathematical model as follows: $Y=0.01318.e^{0.0179TX}$. By the Chi-square test for goodness of fit shows that, the expected value is fitness with the actual value of observaions. So, this model can be used for detects the first peak phase of occurrence of SRG, and provides a reference to determine the proper date for SRG control.

#20

A STUDY ON LETHRUS APTERUS-A NEW PEST ON THE DESERT STEPPE. Ting Lu, Huizhu Wang, Xi Wang, et al (Department of Grassland, Gansu Agric. Univ., Lanzhou 730070, China)

The biological and ecological characteristics of the big-head beetle Lethrus apterus that harms the herbage on the desert steppe and steppe-desert grassland is reported first in the paper. The results show that the scarab conducts oneself with one generation a year, surviving the winter by the imagoes in soil, harming Artemisia dalailamae etc. Distribution on the desert steppe makes a feature of which the weightier soil texture (or soil unit) and the lower soil moisture content, the higher insect density. Damaging peak period of the adults' is form the June to the first ten-days of July in the whole year. When its density is 1 head m^2, the herbage mass is lost by 14-17%, 3-4 heads m^2 -43.44-55.28%, 6-7heads m^2 -84.31-94.04%, 0.4 heads m^2 would be allowed economically. Applying insecticide emulsion of either 40% Rogor or 80% DDVP (1:1500), both achieved effectiveness of prevention and control of 89.4-95.6%.

#21

THE POPULATION DYNAMICS AND INTEGRATED MANAGENT OF ASIATIC LOCUST (LOCUST MIGRATORIA L.) IN XINGJIANG, CHINA. Fu-lai Fan, Yuan-xin Wan (The Control Station of Locust and Rodent Prediction and Control of Xingjiang Uygur Autonomous Region, Xinjiang 830001, China)

The paper deals with circumstances of the asiatic locust that happened during the 1950's to present, analyze the characteristic habitat, the changes of natural conditions, the influences on the ecological environment by humen activities, and the result of control measures. The main distribution of the locust in Xingjiang is the marshes around the overflow belt of phreatic water and lakes, and the marshes along wide river valley plain. The rainfull among mountains determines quanlity of river flow which, in trun, influences the water level of marsh, ecological environment and the population density of asiatic locust. During the drought year, or the following one or tow years, the harmfulness of locust will become very serious. On the other hand, through the reclaimation for farming and water conservacy constraction that change the ecological habitat will give different results, that is to say it may benefit or unbenefit for the locust. The effcitive measures of administering the pest problem is by carring out the guiding line "reform and control simultaneously" and strengthen prediction prompt control, change ecological habitat of the locust by water conservancy construction.

#22

UTILIZING RESISTANT CROPS IN CULTURAL CONTROL OF GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE). O. Olfert, C.F. Hinks and N.D. Westcott. (Agriculture Canada Research Station, Saskatoon, S7N 0X2, CANADA).

Grasshoppers are the most important insect pest of cereal and forage crops in Western Canada. Grasshopper feeding may occur throughout the growing season of May to September. When severe grasshopper outbreaks occur, crops are protected primarily by the application of insecticides. Cultural control strategies are being investigated to reduce the industry's dependence on chemicals for grasshopper control. Guard strips of weed-free fallow (10 - 20m wide) around the periphery of fields are recommended in areas where headlands are infested with grasshoppers. However, summerfallow has some major disadvantages: accelerated loss of organic matter; increased susceptibility to wind and water erosion; and excess moisture that can contribute to salinity.

As an alternative to guard strips of fallow, the use of crops showing resistance to grasshoppers was examined. Two crops were tested for their suitability in guard strips: oat (*Avena sativa* (L.), cultivar Cascade); and feedpea (*Pisum sativum* L., cultivar Sirius). Either can be incorporated into the soil as a green manure or harvested for grain. Both guard crops were evaluated for their effects on grasshopper populations and their susceptibility to grasshopper feeding. Feeding on oat or feedpea had adverse effects on grasshoppers, including increased mortality, delayed growth and decreased egg-laying. The benefits of incorporating grasshopper resistant crops into cultural control strategies are two-fold: reduced frequency of insecticide application; and prevention of soil degradation. Both approaches are supportive of the aims of sustainable agriculture.

#23

CONTROL OF GRASSHOPPERS IN SOUTH DAKOTA, USA. Billy W. Fuller, Tie Wang, Nelson Foster, Evelyn Kahler, and Mark Boetel. (Plant Science Department, South Dakota State University, Brookings, South Dakota, 57007 USA).

Grasshoppers are serious pests of rangeland grasses and many of the row crops of eastern South Dakota. Our efforts in conjunction with the United States Department of Agriculture, Animal Plant Health Inspection Service have proven that aerially applied treated bran flakes can be highly effective in reducing grasshopper populations below economic injury levels on rangeland. However, utilization of treated bran baits on fields with dense plant vegetation in eastern South Dakota have had limited success. A full review of our grasshopper laboratory and field research from 1988 through 1991 will be provided.

#24

STUDIES ON FORAGE CUT-OFF LOSSES CAUSED BY FEEDING OF GRASSHOPPER CHORTHIPPUS DUBIUS (ZUB.). Hong-chang Li & Wei-min Fan (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The seasonal dynamics of the forage cut-off losses caused by the feeding of grasshopper Chorthippus dubius (Zub.) is reported in connection with its differe-nt population density. This experiment was carried out in the research area of Grassland Ecosystem Reserch Station of Chinese Academy of Sciences, situated near Iheula Mountain in Xilin River Basin Region of Nei Mongol (Inner Mongolia). The results of this experiment are suggested as follows: 1. The correlation between the average amount of forage cut-off losses (Y) by the grasshopper and its population density (D) appears as a logarithmic curve (fig.2); 2. A series of formulae used for calculating the amount of forage cut-off losses in the grasshopper's different stages from nymph to adult are established and indicated as follows: $Y=1.6734-1.5498LnD+2.7176N$, $Y=0.1490^{2.4352}.\exp(-0.1496t-0.0191D)$, $Y=-0.9744-1.2431LnD-0.0513t$, $Y=9.5471-1.5053LnD-0.0513t$; where, Y=the average amount of cut-off losses of forage by each individual grasshopper, D=the population density of grasshopper, N=different stages of the grasshopper, i.e.: if it is the early instar (1st+2nd), then N=1; if it is the medium instar (3rd), then N=2; if it is the late instar (4th+5th), then N=3; t=developmental duration of adult grasshopper

#25

THE OCCURRENCE AND CONTROL OF LOCUSTA MIGRATORIA MANILENSIS (MEYEN) IN SAN MEN XIA RESERVOIR AREA OF SHAANXI PROVINCE. Xing Liu, Fuchang Sun, Youxin ma, Gaohua Li, Yaqin Pan, (Xi'an Animal and Plant Quarantine Service, Xi'an 710068, China) Baoling Li (Plant Protection Institute of Shaanxi Province, China)

A new river-widespread locust occurring area emerged in San Men Xia reservoir area where is the cross of Hanghe River, Weihe rever and Lohe river of east Shaanxi province in 1960's early. The total numbers of locust disaster were 14 years/times. The locust (Locusta migratoria manilensis occurred 2 generations per year in this reservoir area. The overwintering eggs cluster contained 40-80 eggs, not more than 120 eggs. The overwintering mortality was 4-17 per cent. The beginning of May was outbreaking stage of hatching. Emergence stage was on June 6-16. The growth of summer nymph lasted 36 days. The sexual proportion (female/male) of summer nymph was 1:5-10. The autumn nymph hatched on July 19-21. Its adult could be seen on August 15. The locust emerged for 26 days after it came out of soil. The growth of autumn nymph was very in disorder. Its adult and 2-5 instar nymph swarm could be seen on August 15-17. According to the experience of over the years, we had made four measures about eradicating this locust.

#26

BIOLOGICAL CONTROL OF GRASSHOPPERS AND LOCUSTS USING NOSEMA LOCUSTAE BAIT IN CHINA. Yuhua Yan, L.Zhang and L.Y. Wang (Department of Plant Protection, Beijing Agricultural University, Beijing, 100094, China)

From 1985-91, the experiments have been carried out. The Oriental Migratory Locust(OML)-Locusta migratoria manilensis was infected with Nosema locustae(N.L.). More than $6x10^9$ spores from each locust were obtained. An insectary with capacity to producing N.L. concentration about $1x10^{16}$ per year has been set up. At present, N.L.concentration is not expensive in China. There were 26,000ha of rangeland treated with N.L. last Summer. The density of infected grasshoppers showed 59% motalities in the treated plots and 35% infection among the surviving population six weeks after treatment. The trial of application of N.L. for control of OML under the area of optimum habitats about 200 ha showed that the densities of OML were reduced by 40-60%, as compared to the control. The percentage of infection by N.L. among the surviving population was 70-80%. The spores obtained from one infected locust were $2.7x10^8$ and their reproductive potential was highly reduced. Using a computer connecting with a device of testing flying ability of insects showed that the mean flying length of an infected adult was 864 m. in 18 h, far less than that of a healthy adult, 14,279 m. Mean flying speed rate of an infected adult was 0.51m/sec. The results indicated that N.L. is potentially useful in IPM program for managing the densities of the pests.

#27

CENTER FOR BIOLOGICALLY INTENSIVE INTEGRATED PEST MANAGEMENT AT TEXAS A&M UNIVERSITY. R. E. Frisbie, J. W. Smith, Jr., P. L. Adkisson, L. T. Wilson & R. N. Wiedenmann (Department of Entomology, Texas A&M University, College Station, Texas USA). Sustainable agricultural production requires pest management strategies with reduced reliance on chemical inputs. In response to this need, the Center for Biologically Intensive Integrated Pest Management was established in 1991 at Texas A&M University to develop and deliver biologically intensive IPM systems that will cause a major shift in pest control, from chemically based to biologically based technologies. Major goals of the Center are reducing pesticide loads on the environment and increasing agricultural profitability by improving the predictability of biologically based crop production. The Center serves to coordinate development of tactics and strategies for pest management, using research into advanced technologies in the areas of ecosystem science, biological control, host plant resistance and cultural manipulation. The Center has secured a planning grant from the US-EPA to organize a national, multi-crop pesticide pollution prevention research program, and has taken an active role in writing planning documents for the USAID Collaborative Research Support Program on IPM. The Center coordinates research and extension for integrated management of sweet potato whitefly in Texas, and initiated the organization of a multiple-state project for whitefly management. The Center also has research projects on management of Diamondback moth in Texas, a Geographic Information System modelling initiative for boll weevil, and a USAID project for biological control of native stalkborers.

#28

Three-hourly changes in population density of arthropods in a paddy field.

Hassan, S.T.S.,Wahid, N.A., Seman, S.A. & Yatim, M.R.M., Department of Biology, Universiti Pertanian Malaysia, 43400 UPM, Serdang, Selangor, Malaysia.

Numbers per hill of arthropods in a wet paddy field was monitored at three-hourly intervals, one day per week in a growing season. For all species , there were significant differences in mean numbers between many of the three-hourly samples. In most pestly species (*Nephotettix* spp., *Nilaparvata lugens*, *Cofana spectra*, *Recillia dorsalis* & *Sogatella furcifera*) and two predatory species (*Cyrtorrhinus lividipennis* & *Paederus fuscipes*), there was a gradual rise in numbers from 0600 to 0900 h, a decline at 1200, a significant rise at 1500, followed by a gradual decrease towards 0300 h. For *Recillia dorsalis*, the numbers increased significantly at 2100 and 2400 h, peaking at the latter hour. The nocturnally active pestly pyrallids showed very low means during the day, but numbers were significantly higher during the night, peaking at 2100 and 2400 hours. The predatory dipterans and spiders were also higher in numbers during the night than during the day light.These findings have important implications for sampling, including those for pest management purposes, since almost all usual sampling hours are restricted to the daytime only.

#29

COMPARATIVE DEMOGRAPHIC STUDY ON TWO MALAYSIAN DACUS SP. (DIPTERA: TEPHRITIDAE). Tock-Hing Chua (Department of Zoology, Universiti Malaya, 59100 Kuala Lumpur, MALAYSIA)

Demographic study was conducted in the laboratory on two Malaysian species of the Dacus dorsalis complex, viz. Malaysian A (Mal A, ex starfruit and guava) and Malaysian B (Mal B, ex guava) using first generation populations. Dacus Mal A reared from starfruit generally lived longer and were more fecund than those from guava, indicating that the larval food of Dacus Mal A had a great effect on the reproductive potential and survivorship of the adults. The parameters obtained for Dacus Mal A ex starfruit, ex guava and also Mal B are given below respectively. The expectations of life at eclosian are respectively 74(female), 137(male); 63, 82; 77 and 84 days. The gross fecundity values are respectively 660, 363 and 402 eggs, with mean per day per female of 7.8, 4.0 and 5.1. The gross egg hatchability rates are respectively 58%, 44% and 42%, while the gross fertility are 385, 160 and 244 eggs. The intrinsic rates of increase (r) are respectively 0.104, 0.059 and 0.092 and the net reproductive rates (R_0) are 167.5, 31.7 and 176.8♀ eggs/♀. The generation times are 82.5, 56.5 and 63.5 days, while doubling times are 6.7, 11.7 and 7.6 days.

#30

DEVELOPMENT OF POWERFUL TRAPS FOR CONTROL OR MONITORING MEDFLIES. (Ceratitis capitata). Zervas G.A. (Institute of Biology, NRC "DEMOKRITOS", Athens, Greece.

Traps of low cost and easy to serve were constructed for the Medfly. The efficiency of these traps was compared in the field with traps of known efficiency.

a. A reversed plastic cup of 8 cm diameter and 6 cm depth, baited with Trimedlure (TML), attracted and killed many more male medflies than other known traps. (Jackson, McPhail). The attracted flies in the trap, were killed by the insecticide which was coated with sugar in the inner surface of the cup.

b. A dry trap for medflies was constructed and further improved. The trap was baited with TML and insecticide (DDVP) both eluded from dispensers. It was made of a reversed transparend plastic cup of 11 cm diameter and 10 cm depth with six holes of 1.5 cm diameter on the side wall of the cup for the entrance of the flies. The trap was of high efficiency and safe against losses because of Ants, Vesps and Vapour action of DDVP outside the trap.

c. The plastic McPhail trap baited with both TML and Protein hydrolysate has been found to be a powerful trap for monitoring medflies.

#31
THE SIGNIFICANCE OF WARNING FOR PLANT PROTECTION IN IRAN.
Ahmad , Rassipour (Plant Protection Organization , 2 Tabnak St.Evin , Tehran , Iran).

Initial steps in pest management were taken depending heavily on quick control methods including use of pesticides.During the recent years continuous usage of pesticides have led to the outbreas of certain pests, occurance of resistant races enviromental pollution , and adverse effects on the ecosystem.Through using warning systems for orchards and farm crops efforts have been made to control the populations of major pests while avoiding the unreasonable chemical applications ,the health effects of which are known to everyone. in practising warning against moths sex pheromones have been utilized in insect trapping and timing of the occurance and activity peak allowing the advantageous timing of control, Complementory to this are making visual observations and setting up monitoring networks.The system has resulted reduced pesticide applications in orchards of major fruit growing areas lowering spraying from 8-10 times a year to 3-4 times which means a 50% reduction in pesticide use.

#32
STUDIES ON THE SPACIAL DISTRIBUTION OF THE CUCUMBER PLANTS INFESTED BY POLYPHAGOTARSONEMUS LATUS AND SAMPLING TECHNIQUE. Chen Bing-shu, Li Hui-li, Wang Huai-qing (Institute of Plant Proteetion, Tianjin Aeademy of Agrieultural Seienees, Tianjin 300112, China)

Based on the data of systematic observation taken from the cucumber plants in glasshouses (unheated) at west suburb of Tianjin in 1986 and 1987, using m^*-m method, the spaeial distribution of eucumber plants infested by Polyphagotarsonemus latus and sampling teehnique were studied. The results showed that the general relationships between m′ (ratio of the infested plant) and m^*/m (aggregation index), I (index of the infestation) and m^*/m are given as follows respeetively:

$$m^*/m = 6.7238 - 10.9706m' \pm 2.26 \quad (r = -0.7887^{**})$$
$$m^*/m = 6.4895 - 0.1779I \pm 2.33 \quad (r = -0.7733^{**})$$

When m′ is less than 0.5271, the distribution pattern of infested plants is an aggregate type, when I is less than 30.86, the distribution pattern represents an aggregation either. Otherwise, it will be an uniform distribution.

Meanwhile, the sampling number varies with different infested degrees: as the infestation getting heavier, the number will go down evidently.

#33
SIMULATION MODELS FOR MANAGING THE LONG DISTANCE MIGRATORY RICE PLANTHOPPERS.
T. Watanabe and K. Sogawa (Lab. of Pest Management Systems, Kyushu National Agricultural Experiment Station, Nishigoshi, Kumamoto, 861-11, Japan)

Simulation models of rice planthoppers, Nilaparvata lugens and Sogatella furcifera, were developed to predict the population growth and to quantify the infestation levels on the rice crop, which are formulated with the transition matrix operative under the variable temperature conditions. Immigration date and density, survival rate, proportion of brachypterous females, spiders density and temperature are the main parameters involved in the models. Sensitivity analysis indicated that the survival rate and proportion of brachypterous females were the most effective parameters contributing to the peak density of the planthopper population. Dry matter reduction by the planthoppers on rice crop was calculated coupling the feeding rate to the models. Hopperburn areas caused by severe infestations with N. lugens was estimated from the equations defined by the mean densities of immigrants and peak generation progeny, and the degree of aggregation.

#34
A STUDY ON A NEW SPECIES. HYDRELLIA SINICA FAN ET XIA. AND THE MATHEMATICAL MODEL OF THE ADULT POPULATION DYNAMICS IN PADDY FIELD.
zhou-yuan Xu , Da-yong Jin (Yan Bian Agricultural College, Jilin Province 133400 . China) He Yong-qing, Xiao-dong Wang (Hun Jing Plant Protetion Station) Dong-xi Li (Long Jing Plant Protection Station, China)

According to investigation on H . sinica in Jilin, Hunjiang, Yanbian etc. regions during 1989-1990, this paper first reported that leaf miner damaging rice in these regions is H . sinica, one of two new species of genus Hydrellia. The key distinguishing the adult sex is that whether are paranal lobe etc. external structure in the end of adult abdomen. This is a new method and the accuracy is over 98% . According to investigation data in Longjing, Yanbian during 1984-1990, using analysis of covariance, we have established a population dynamics model of H. sinica adult, $p = 0.8660 + 0.140\times$. The model is tested by the regression equation of eggmasses dynamics. According to the model, we suggest that the adult flight and egg laying ought to be monitored on May 20 to June 20. respectively. The model is to be used for controlling H . sinica adult in recent three years , the control effects reached 84.1-86.3%.

#35
USE OF Y OLFACTOMETER TO DETERMINE THE ATTRACTIVENESS OF SORGHUM GENOTYPES TO Aprostocetus diplosidis CRAWFORD, 1917. Lara, F.M. (FCAV-UNESP/CNPq,14870 Jaboticabal , SP, Brazil), A.R.Campos (FEIS, UNESP, 15378 Ilha Solteira, SP , Brazil), E. Berti Filho (ESALQ-USP,13400 Piracicaba,SP,Brazil).

The behaviour of sorghum midges's [Contarinia sorghicola (Coq.,1898)] parasitoid in relation to parts of plants, of some sorghum genotypes, were investigated using Y olfactometer in Entomology Laboratory of Faculdade de Engenharia de Ilha Solteira-UNESP, SP, Brazil.

At the first experiment was tested the attractiveness of leaves, of panicles with and without flowers, and milky grains of IPA-201 genotype. At the second it was used only panicles with flowers of AF-28, IAC-83/75-5-1-6, TX-2536, BR-300,IPA-201 and Sart genotypes. The panicles used in all tests were protected from sorghum midge attack, and 20 adults of A.diplosidis were used by replication; they were maintened for 20 minutes in observation during the tests. In one phase the genotypes were tested 2 by 2, making all possible combinations; in another one , each genotype was compared with a blank treatment, from where it was calculated an index to correct the obtained data between genotypes.

The results showed: 1-the panicle with flowers were the most attractives to A.diplosidis; 2-the panicles without flowers were the less attractives; 3-the panicles of AF-28 genotype, resistant to the sorghum midge, were the most attractive to the parasitoid, among the panicles of evaluated genotypes.

#36
STUDIES ON THE ELECTRIC LIGHT TRAPS IN THE CONTROL OF THE ASIAN CORN BORER. Yun-sheng Wang, Rong Zhang, Gui-hua Yang, De-rong Yue and Jian-ping Li (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Gongzhuling 136100, China)

The Asian corn borer (ACB), Ostrinia furnacalis (Guenée), is a serious pest of maize. Maize was major attacked by first generation in Jilin province. The ACB passes the winter as mature larva in the maize stubs in residential areas of countryside where larvae were a source of moths for egg laying in maize field. Source of illumination was all of the high intensity mercury-vapor type of 200-w and 400-w sizes. They emitted blent light with wave-length peaks at 365-578nm. Each light trap was installed approximately 150m apart. The attractive moths were collected by a round cistern (diameter 1.2m) under the light where they were killed by water and washing powder. Field studies of operative technique and effect were made in 1987-1990. A total of 7600 electric light traps were installed in the residential areas of countryside in Jilin province, and controlled area reached to 156000 ha. Large-scale field experiments show that the use of electric light traps were effective against the ACB, the decreased percentage of egg masses were 71.1%, the averge controlled effect was over 65%, incresed yield was about 600kg/ha, and the ratio of cost to output was 1:40.

#37

STUDIES ON THE MONITORING OF THE QUANTITY OF SPIDERS AND ITS EFFECT OF CONTROLLING PESTS IN RICE FIELDS. Guoqing Du (Plant Protection Station. Luan Region. Anhui Province 237001, China)

By field inspection. we have identified 36 species belonging to 10 families of spiders in rice fields within Wanxi Rice Belt in Anhui Province. Main species of them are altogether 8 species, such as Dedothorax insecticeps Boes et Str, Dyschiriognatha quadrimaculata Boes et Str. etc.. A threshold autovegressive model was established with the histonic information:

$$Z_K = \begin{cases} 26.0 + 0.128Z_{K-1} + \Sigma_{K1} & Z_{K-1} < 34.5 \\ 77.9 + 0.124Z_{K-1} + \Sigma_{K2} & 34.5 < Z_{K-1} < 77.2 \\ 66.5 + 0.446Z_{K-1} + \Sigma_{K3} & Z_{K-1} > 77.2 \end{cases}$$

Based on the model, a medium and long-range froecast about quantity of spiders can be performed.

The predatory effects of several main spiders to plant hoppers have been measured by functional response in laboratory. Estimating the ability of controlling pests with ratio of a/T_h, then instantaneous attack rate of various spiders follow: Dyschiriognatha quadrimaxutala> Dedothorax insecticeps>Clubiona japonicola>Pirata subpiraticus> Plexippus setipes.

#38

STUDY ON INFLUENCE OF THE GREEN PEACH APHID UPON QUALITY AND ECONOMIC VALUE OF FLUE-CURED TOBACCO AND ITS ECONOMIC THRESHOLD. Feng Yuan (Department of Plant Protection, Northwestern Agricultural University, Yangling, Shaanxi /712100, China)

There are 6 species of aphid flying and migrating to tobacco plants in Xianyang Distr., Shaanxi Prov., China, but only can *Myzus Persicae* (Sulz.) do damage to tobacco. Tobacco plants are divided into grade O. Ⅰ, Ⅱ, Ⅲ and Ⅳ according to the aphid quantity per plant in the period of its serious damage, and leaf area polluted by mould caused by honey dew secreted by the aphid in the period of tobacco ripening. Compared with grade O not injured by the aphid, the mid- and high-grade tobacco leaves in grade Ⅰ, Ⅱ, Ⅲ and Ⅳ injured by the aphid are reduced by 6.93%, 13.05%, 28.51% and 30.94% respectively in 1990. The economic losses caused by the aphid are 9.86%, 23 81%, 36.12% and 39.59% respectively. The analyses of chemical composition indicate that nicotine of the leaves in grade Ⅰ, Ⅱ, Ⅲ and Ⅳ is reduced by 10.61%, 19.29%, 10.61% and 25.40%, reducing sugar is reduced by 15.04%, 19.23%, 40.78% and 44.86%, and protein is increased by 16.17%, 31.77%, 37.02% and 38.72% respectively. These show that both the external and internal qualities of the flue-cured tobacco leaves are influenced by the aphid injury. An investigation of the economic threshold indicates that when pesticides are applied to control the aphid, the standard of aphid quantity in the fields should be determined according to tobacco's growing well, better or worse. For the standard to control the aphid in three different types of tobacco fields, the average aphid quantity per 100 tobacco plants is 1000, 1500 and 2000 respectively.

#39

OVERCOMPENSATION, A CHALLENGE OF STUDY IN INTEGRATED PEST MANAGEMENT. C. F. Sheng (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The author collected a large number of evidences showing that the overcomopensation of crops for insect feeding or mechanicat damage exists widely. These crops include cotton, okra, tomoto, potato, egg plant, melon, cucumber, bean, peanut, vegetabte, cereat, sunflower, sesame, sweet potato, beel, safflower, lolus, lily crops and fruit trees. The major internal and external factors determining the overcompensation are property of crop variely, growth stage, feeding amount, feeding site, and water, fertilizer, energy, time, as well as space available in the environment. These factors relate to each other and function in a combining manner. The overcompensation occurs when the stress of limiting factor is reduced to a certain exlent. Compensation is an adaptation of a crop to the ftucluating environment. The basic reason for overcompensation is believed to be a reduction of growth redundancy of crop plants either by insect feeding, crop breeding or growing practices. And the growth redundancy is generatly found, especiatly under the conditions of intensive farming. The overuse of insecticides is due to the lack of study of the overcompensation. Searching for and enhancing the overcompensation are expected to improve the present integrated pest management, which is demonstrated in control of cotton insects in China.

#40

DESIGN AND APPLICATION OF NEW TYPE OF TRAPPING LAMP WITH DOUBLE WAVES. Li-Chun Liu(Yanjiang Institute of Agriculture,JiangSu, 226541,China)

It is indicated the monochromatic light for insect trapping peaks at the 365nm, 450nm and 525nm. Showing the reaction range in spectrum is wide. Thus, the improvement of trapping illuminant requires both long and short waves. Double-wave lamp 1-4, have all meet the requirememt above. Their characteristics show (1) high efficiency in insect trapping.(2) the peaks show more obviously.(3) reducement of number of killed natural enemies. Double-wave lamp is available and acurate in prediction. Ovarium dissect shows a correspondent result to the actual ovulation of Heliothis armigera and Ostrinia nubilalis,the prediction to Chilo suppressalis Walker and Cnaphalocrocis medinalis can be proved by the actual condition in the field while deviation is observed with black-light lamp prediction to the third generation of pink bollworm with double-wave lamp ajointed with sex-attractant is much suprior to regular prediction.On the other hand, the reducement of ovum by 66.30%-79.15% result in the decrease of area, number of times as well as labours of insectcide spraying.Rate of stem-bore by Ostrinia nubilalis reduces by 59.33%.

Double-wave lamp has two peaks at 350nm and 585nm.After the latter light attract the remote insects to be near the lamp,insects become dassled by the former light to prunce.So,the long-wave light acts as a"signad" while the short-wave light as a"vertigo".The Double,effects is the main reason fordouble-light lamp' s suprior to the black-light lamp.The reducement of number of killed natural enemies is, possiblly, related to the brightness erount the lamp.

#41

A NEW MODEL FOR PRESENCE-ABSENCE SAMPLING. Eizi Yano(Science and Technology Agency, 2-2-1, Kasumigaseki, Chiyodaku, Tokyo 100, Japan), Norio Yamamura (Department of Natural Science, Saga Medical School, Nabeshima, Saga 840-01, Japan)

Presence-absence sampling is a simple and convenient way of estimating the density of an insect population. This method has already been used as monitoring technique for spider mites and some lepidopterous insects. The mean density is estimated from the relationship between the mean density and the ratio of the presence of insects in samples. Several equations have been proposed to describe this relationship. Most of them are based on the assumptions that population distributions are described by simple theoretical distributions or simple relationships between means and variances. We developed a mathematical model to describe the relationship between the mean density and the ratio of the presence of insects in samples. The model assumes the linear change of the ratio of the presence and the exponential change of the mean density with time. The model can be simplified as simple equations for logarithmic or exponential curves. The two parameters of the model are calculated by nonlinear methods of least squares. The model described the actual relationship of whitefly very well.

#42

BEHAVIOR AND SURVIVAL OF *SPODOPTERA EXIGUA* ON *APIUM* ACCESSIONS. M. M. Diawara, J. T. Trumble, J. G. Millar, (Dept. of Entomology University of California, Riverside, CA 92521, USA), C. F. Quiros (Dept. of Vegetable Crops, University of California, Davis, CA 95616).

Two *Apium* accessions were compared with the commercial cultivar 'Tall Utah' 52-70R (*A. graveolens [L.]*) for resistance to *Spodoptera exigua* (Hübner). Oviposition rate was not significantly different between genotypes. The plant accession *A. prostratum* ssp *prostratum* var filiform (A230) showed a significantly higher resistance to *S. exigua* than 52-70R. The levels of carcinogenic and mutagenic linear furanocoumarins in the commercial cultivar 52-70R and in the plant accession *A. nodiflorum* were far below the concentration reported to produce acute contact dermatitis. The levels of furanocoumarins in *A. prostratum* petioles and leaves were 10 and 18 times higher, respectively, than the concentration known to cause contact dermatitis. However, resistance in *A. prostratum* was primarily due to non-preference and the linear furanocoumarins did not induce non-preference. Therefore, the resistance shown by this plant accession does not appear to be furanocoumarin-based and may be suitable for transfer to commercial celery for use in *S. exigua* management.

#43
INVESTIGATION ON POPULATION DYNAMICS & DAMAGE RATE OF THE CHICKPEA POD BORERS IN WEST AZARBAIDJAN, IRAN. Heydar Adldoost (Agricultural Research Center, Urmeyeh, West Azarbaidjan, Iran)

About 70000 ha. chickpea (Cicer arietinum L.) is cultivated in West Azarbaidjan. Pod borers cause damage to this crop.Heliothis viriplaca & Helicoverpa armigera are the main species respectively in dry & irrigated lands.

Marasmarcha sp causes damage only in dry lands. Heliothis peltigera does not damage chickpea.

During a survey from 1987 till 1989, pod infestation in dry lands ranged from 0 to 6.2% & in irrigated lands from 6.1% to 8.2%. However paired observation trials in dry land had no significant difference in yield between protected and unprotected plots.

Two Hymenopterous parasites naturally control the Heliothis larvae up to 83%.

#44
IMPACTS OF OVERWINTERED FLEA BEETLE ADULTS ON NUTRIENT GROWTH AND YIELD OF RAPE ORO AND THEIR ECONOMIC THRESHOLD. Zhao Limin (The Institute of Plant Protection, Qinghai Academy of Agriculture and Forestry, Xining, Qinghai 810016, China)

Analysis of correlation coefficients and regressions of data from experimental plots in Datong County, Qinghai Province in 1987 and 1988 indicated that:

1. infestations of overwintered flea beetle adults (OFBA), primarily *Phyllotreta vittata* Fabr. and *P. humilis* Weise, reduce the exponential growth rate of the crop as well as delay the time of flowering stage.

2. Significant negative correlation (r=-0.91 to -0.96) were observed between the 5-leaf seedling fresh weights and the summation of weekly of OFBA densities per seedling until June 2 (2 days following the peak occurrence).

3. A significant positive correlation (r=0.86) was observed between percent losses of rapeseed (Y) and the summation of weekly OFBA densities per seedling (X) until the end of their occurrence, Y=-0.92+3.13X.

4. The economic threshold of OFBA was calculated as 3.6 individuals per square meter at their peak occurence.

#45
STUDY ON OCCURRENCE REGULARITY AND COMPREHENSIVE CONTROL TECHNIQUE OF CRUCIFEROUS VEGETABLE APHIDS. Zhong-lian Lai (Guizhou Agricultural Academy of Science, Guiyang 550006, China), Guishu Chen, Hongchang Zhang, Weihong Jin (Guiyang City Vegetable Office, Guiyang 550003, China), Hong Lai (Huaxi District Agritechnical School, Gulyang 550003, China)

The peak of occurring season of Myzus persicae (Sulzer) is from the last ten days of April to the first ten days of May; Brevicoryne brassicae (L.) from the first ten days of May to the middle ten days of May; Lipaphis erysimi (Kaltenbach) the last ten days of May.

Early varieties could avoid the peak period. The way of picking off the basic leaves could reduce the rate of reproduction of aphids. Natural enemies could control aphids effectively. The control efficiency of ladybird Coccinella septempunctata (L.) transferred was over 80% . Ground covered with plastic film was earlier harvest, evading the peak of aphid population, increasing by about 20% in yield. The resistance to 40% dimethoate has been acquired by aphids, and control efficiency fell to lower than 70%. But, the control-efficiency increased by 90% if 40% dimethoate and 2.5% Deltamethrin of 50% phoxim or 25% shachongshuang solution were mixed.

#46
INVESTIGATION ON THE SPECIES OF SUGARBEET RUSSELKAEFER AND ITS CONTROL IN THE NORTHERN PART OF CHINA. Changxue Sun, Yanli Zhou, (The Sugarbeet Research Institute, Chinese Academy of Agricultural Sciences, Hulan County, Heilongjiang 150501, China), Qingxin Meng (The Agriculture Service of Chifeng City, Liaoning, China), Rong Zhang (Ningcheng Sugar Refinery, Chifeng City, Liaoning, China)

The species of sugarbeet russelkaefer were investigated in the Northern part of China in 1979 to 1987. 23 species were found, of which the main species were: Bothynoderes punctiventris Germar, B. securus Faust, Xylinophorus mongolicus Faust, Mesagroicus sp., B. libitinarius Faust, Tanymecus variegtus Gebller, Chromoderus declivis Olivier, Lixus subtilis Boheman and so on. More than 10 kinds of insecticides were used in the seed treatment (more than 20 medicament forms, 30 formulations) in 1980. We have chosen the best one-methylcyolane (made in Shanghai, China) . The optimum methods were seeds sealed, wet seed dressing and seed coating the rate of insect killing by toxic seedling were 80% to 100% , and could keep the effectiveness to 70.7% to 85.8% until 35 days after sowing. In the demonstration, during 1982 to 1984, we also used this methods, rate of killing was 82.1% to 100% , and the establishment rate of seedling was 88.1% to 97.9% and 50% losses was redeemed. During 1985 to 1991, we have gotten good controlling effectiveness in 2 to 6 million mu each year, 13% to 17% losses were redeemed generally, and also redeemed 50% losses in the severely harmed conditions, and other insects could be controlled.

#47
ASSESSMENT OF DAMAGE TO WATERMELONS BY APHIS GOSSYPII (HOMOPTERA: APHIDIDAE). B. Cartwright, Dept. of Entomology, Oklahoma State University, POB 128, Lane, Oklahoma 74555 USA

Studies were conducted in 1990 and 1991 to determine the effects of feeding by melon aphid (Aphis gossypii Glover) on the growth, development, yield and quality of watermelons (Citrullus lanatus L.). Selective applications of insecticides were used to maintain a gradient of aphid populations in field plots in both years. Significant negative regressions were observed between yield, various plant growth parameters and aphid density. In 1990, high levels of aphids delayed watermelon fruit set and decreased total numbers of fruit produced. The incidence of the physiological disorder known as blossom end rot increased with greater aphid densities. Aphid-induced losses varied among cultivars and among years. Generally, more advanced germplasm was affected to a greater extent than was older watermelon lines. Net economic returns of watermelons declined significantly as melon aphid density increased. A preliminary action threshold for melon aphid on watermelon is proposed.

#48
STUDY ON THE DYNAMIC ECONOMIC THRESHOLD OF GREENHOUSE WHITEFLY ON CUCUMBER. Guo-ren Zhu, Zheng-li Ju, De-lu Qiao, Jian-zhou Zhao, Bao-yun Xu (Institute of Vegetable and Flower Sciences, Chinese Academy of Agricultural Sciences, Beijing 100081,China)

In 1986-1988, the population dynamics and damage of greenhouse whitefly Trialeurodes vaporariorum Westwood to cucumber were studied in large jointly-strided greenhouses. Its economic injury level was determined as 250-300 adults/plant, and based on its population increase model of adult: N_t = 0.0015 exp 0.1198t, the dynamic economic threshold model of this insect pest was developed as: ET = 192.5855/exp 0.1198 Ta ; where t = the day number since Feb.10, N_t = the adult number on t,Ta = the day number after transplantation, and ET = economic threshold. The application of this dynamic ET in chemical and biological control of T. vaporariorum, and in addition, the research technique of ET were discussed.

#49
CHARACTERIZATION OF THRIPS INJURY TO ONIONS AND ITS ROLE IN THE DEVELOPMENT OF PURPLE BLOTCH DISEASE. C. L. McKenzie, B. Cartwright (Oklahoma State University, Dept. of Entomology)

Greenhouse studies were conducted to determine the role of thrips injury in the invasion of the fungal pathogen, Alternaria porri (Ellis), and the subsequent development of the disease purple blotch. A laboratory colony of Frankliniella fusca (Hinds) was established from a field population and was used as the infestation source. Individually potted onions (Allium cepa L.), cv. 'Walla Walla Sweet', were placed in microcages and infested with 5, 10 and 15 adult thrips per plant. After a 14 day exposure period, the onions were inoculated with a distilled water suspension of A. porri (1250 and 2500 conidia per ml). The progression of disease was monitored through 20 days post inoculation. Plant growth was negatively correlated to levels of thrips feeding. Development of purple blotch disease was enhanced on plants which had been exposed to thrips feeding. Scanning electron microscopy was used to characterize feeding holes by thrips and to observe penetration of conidia into onion leaf tissue.

#50
DEVELOPMENT AND FEEDING DYNAMICS OF THE DIAMONDBACK MOTH (LEPIDOPTERA:PLUTELLIDAE) AT DIFFERENT TEMPERATURES. Ai-nong Zhou, Jian-ming Chen (Institute of Plant Protection, Shanghai Academy of Agricultural Sciences, Shanghai 201106, China)

The development and feeding dynamics of the diamondback moth (DBM) was systematically studied using cupping leaves of summer cabbage variety "Xia-Guang" at five different constant temperatures. It was indicated that both mean cabbage consumption and mean consumption rate of DBM were related to larval stage and temperature. There were significantly positive linear relationships between mean consumption rate (CR,mg/day) of various larval instars and temperature (T,°C). The regressional equations were $CR_1=-3.548+0.271*T$ for the first larval instar, $CR_2=-5.260+0.433*T$ for the second, $CR_3=-6.176+0.641*T$ for the third, $CR_4=0.512+0.719*T$ for the fourth, and $CR=-4.794+0.641*T$ for the total larval stage. The total fresh leaves consumed during larval feeding period weighed 117.4,108.0,72.5,85.3, and 95.1 mg at 16, 20, 24, 28, and 32°C respectively. Therefore, the whole DBM field population consumption can be determined and predicted by combining the above consumption rate models with DBM population dynamics. In addition, a significantly negative linear relationship existed between pupal weight and temperature.

#51
DEVELOPMENT OF A DECISION AID TO DETERMINE SILK SPRAYS IN FRESH MARKET SWEET CORN. James J. Linduska (LESREC/Salisbury Facility, Rt 5 Box 246, Salisbury, MD 21801, USA)

Sweet corn grown for fresh markets receives more insecticides than most vegetable crops in the USA. Abundance of insect pests varies considerably; thus, significant improvements in insecticide use are possible through the use of insect trap monitoring and treatment thresholds, which determine when and how often to apply insecticides. Sixty field tests were conducted over a 3-year period to evaluate the accuracy of a decision aid using trap data for timing insecticide treatments during the silking period.

The decision aid accurately predicated the proper treatment schedule in most plantings subjected to low or moderate CEW activity. Under high CEW activity, the aid underestimated the number of treatments required to prevent 5% ear damage. In these situations, tighter schedules should be used to minimize ear damage. In all plantings, recommended schedules suppressed pest populations enough to limit feeding injury to the tips of the ears. Use of the aid can potentially save 2 or 3 insecticide applications per planting compared to the current fixed schedules used by many growers.

#52
SWEETPOTATO WEEVIL, CYLAS FORMICARIUS (SUMMER): STATUS AND MANAGEMENT IN NORTH CAROLINA, USA. K. A. Sorensen, Dept. of Entomology, NC State University, Raleigh, NC 27695-7626.

Cooperative monitoring studies of SPW since 1987 with N. C. Dept. of Agriculture and North Carolina State University have evaluated SPW pheromone source, dosage, trap design and trap placement. Seasonal activity of SPW was determined from collections from 3 traps (Unitrap, Unitrap with screen base, and screen funnel trap) at the Ft. Fisher study site for 1990 and 1991.

SPW infestations remain confined to 12 locations in New Hanover County on the Outer Banks and all are associated with the wild host, seaside morning glory. Though infestations are small and geographically removed from commercial sweetpotatoes (35,000 acres), regulatory officials and the industry remain concerned to any potential threat. Educational programs (poster, meetings, multimedia) and a non-sweetpotato growing area have been ongoing since 1982 and a grid system of traps maintained to document weevil collections and movement. Adults have been collected year round using 10 microgram rubber septa with peak activity in July, August and September (the sweetpotato growing season). Unitraps appear to be more sensitive under N. C. conditions. However, in the grid system the more inexpensive and readily available cotton boll weevil traps have proven satisfactory for SPW detection. Mass trapping over several years has not reduced SPW populations. Plans for an area wide suppression involve mating disruption, host manipulation, introduction of nematodes and trap/kill tactics. Transfer and implementation of technology should keep SPW in abeyance and ensure a stable and viable sweetpotato industry.

#53
RESISTANCE TO *Spodoptera exigua* IN TOMATO ACCESSIONS. S. D. Eigenbrode, J. T. Trumble, W. G. Carson (Dept. of Entomology University of California, Riverside, CA 92521, USA), R. Jones (Dept. of Vegetable Crops University of California, Davis, CA USA 95616)

Sources of resistance to the beet armyworm, *S. exigua*, were identified in a collection of *Lycopersicon* accessions. Key observations were as follows:

- Increased susceptibility was associated with genes conferring increased densities of nonglandular trichomes.
- Reduced susceptibility was associated with large vine size and small fruit size. However, these attributes leave much of the variability (90%) unexplained.
- Larval survival was low on fruit of two of the less-susceptible entries, suggesting that physiological characteristics of fruit may condition resistance.
- Reduced susceptibility of one cultivar may be due to its exceptionally tough fruit cuticle.
- Reduced susceptibility of LA 1320 is associated with reduced larval survival on fruit pericarp tissue, and may depend on high concentrations of alkaloids in the fruit.

#54
DEVELOPMENT AND ECONOMIC EVALUATION OF A LOW INPUT IPM PROGRAM FOR TOMATOES IN MEXICO. John T. Trumble, (Department of Entomology, University of California, Riverside, CA USA 92521), B. Alvarado-Rodriguez (Sinalopasta, Apartado Postal 185 Guasave, Sinaloa, Mexico)

A low input, integrated pest management program utilizing *B. thuringiensis*, pheromone confusion and parasite release was economically superior to the commercial program based on multiple applications of standard chemicals.

Pest control approaches tested included 1) a grower 'standard' chemical program with multiple applications of two class 1 pesticides per application, 2) a reduced-chemical tomato treatment program used in processing tomatoes, 3) an untreated check and, 4) a UC-IPM (low input) program utilizing pheromone confusion, parasite releases, intensive monitoring, treatment thresholds, and use of *B.thuringiensis*. The marketable fruit production was similar between commercial and IPM treatments in the Fall plantings, but much higher in the IPM program during the Winter and Spring plantings. Fruit produced in the IPM program were larger than those produced by commercial practices. Costs of the IPM program were less in all plantings. Net profits (value of fruit at harvest minus the cost of control) were substantially higher in the UC IPM plots than in commercial treatments.

#55

STUDIES ON PEACH APHID PARASITES OF CRUCIFEROUS VEGETABLE FIELDS IN BEIJING AREA. Bao-cai Shi, Hong Lu, Yu-zhi Niu, Zhi-li Zhang (Institute of Plant and Environmental Protection of Beijing Academy of Agricultural and Forestry Sciences, Beijing 100081, China)

3574 parasitized peach aphid, the mummies were collected from cruciferous vegetable fields in Beijing area and reared under laboratory conditions until 2716 parasites emerged. The belonged to 18 species of 13 genera and 8 species of 1550 specimens (57. 09%) are primary parasites, in which, 4 dominant species (Aphidius gifuensis, Diaeretiella rapae, Aphelinus asachis and Aphelinus spp.) occupied 96% of the whole, with A. gifuensis as the most important one (52.4%), the rest 4 species occupied only 4% . b) 10 species of 1165 specimens (42. 9%) are hyperparasites, in which, 5 dominant species, including Asaphes suspensus, Pachyneuron aphidis, Aphidnecyrtus spp., Alloxysta spp. and Phaenoglyphis spp.), occupied 95% of the whole, the rest 5 species occupied only 5%, and c) Generally, the sex ratio was 1 to 0.1-0. 95, except for A. suspensus and P. aphidis when parasitizing the Aphelinidae, i. e. 1:7 in the former and 1:5 in the latter.

#56

PRELIMINARY STUDIES ON THE BIOLOGICAL CHARACTERISTICS OF BRADYSIA MINPLEUROTI. HUA-fang, JIANG.(The Sanming Mycological Institute, Fujian Province. 365000 China)

Bradysia minpleuroti was reported in China for the first occasion. The insect pest hosts in dark humid and closed habitats rich in organic matter or humous matter, whose four stages of life cycle complete in mushroom houses. The larvae, which tended to tunnel into mushroom stems and cause damage when they were crowded, pupated on mushroom beds. As the adults emerged, they couldn't fly instantly owing to their wet bodies and had to crawl on the surface of the compost several minutes to over fourty minutes. When their wings became fully expanded, they could then fly. The reproduction mode of Bradysia minpleuroti is the normal two-sexual reproduction mode, with neither paedogenesis nor parthenogenesis. The first mating of the adults came about 6 to 9 hours after emergence. The adults may have several matings in their life cycle (6-8days), the mating length varied from 1 to 2 minutes up to 42 minutes. The adults produced eggs after 10-12 hours of emergence. The eggs were produced in masses, each having 21 to 219 eggs. The female adult can produce eggs 1 to 3 times; the places where they laid their eggs were varied with the environments. In Agaricus bisporus, the white mushroom cultivated in bed, the eggs were laid on the surface of the casing layer or on mushroom stems near the casing; in Pleurotus ostreatus or Pleurotus sajor-caju cultivated in plastic bags, most of the eggs were laid on the surface layer of the substrates, whereas some were laid on the fruiting bodies. When there were two kinds of substrates in the same cultivation sites i.e. new and old substrates, they tended to lay eggs on old fermented substrates. The adult pests had a strong tendeney towards the special odor discharged by the breaking down or fermentation of organic matter; and a slight phobotaxis towards a mixture of sugar, veneger and achohol as well as an evident phototaxis.

#57

STUDIES ON POPULATION DYNAMICS AND CONTROL OF THE STRIPED BEETLE (PHYLLOTRETA STRIOLATA). Ling Zeng (Guangdong Institute of Cereal Science Research, Guangzhou, 510310, China)

The striped beetle Phyllotreta striolata (Fabr.) is one of the major pests of vegetables in many countries. It caused serious damage to cruciferous crops in some areas of Guangzhou of late years. Field and laboratory studies of inspecting mathod of larvae, the population spatial dynamics and quantitative dynamics were carried out in Panyu County and laboratories of South China Agricultural University from 1987 to 1989. In the light of actual conditions of application of pesticides at present, control efficacy of four efficient and low toxicant insecticides i.e. phoxim, padan, thichlorphon and fenvalerate were tested.

Results showed that the inspecting mathod of larvae by the self-made Tullgren's separators was better than that by hands. The distribution pattern of larvae in cruciferous vegetable fields belonged to an aggreated distribution. The elementary components of distribution were individual colonies. P. striolata was found in Guangzhou all the year round. It had two obviously peaks per year. The population fluctuation was affected closely by foods, rainfall and tempertrue-humidity coefficient. The effectiveness of application by pouring was higher than by spraying, Among these four tested insecticides, padan and phixim gave the best control of adults, phoxim gave an excellent control of larvae.

#58

A NEW ECOTECHNICAL CONTROL METHOD OF TURNIP SAWFLY, ATHALIA ROSAE L. /HYM.,TENTHREDINIDAE/. Gy.Sáringer /University of Agricultural Sciences, 8360 Keszthely, P.O.Box 71, Hungary/

The method is still in the experimentalstage and is based on the susceptibility of larvae against the photoperiod. Larvae reared at a daylength in correspodence with that in September, which has a photoperiod shorter than the critical daylength, show in the scotophase two light sensitive periods. If in these periods the larvae are exposed to light for about 30 minutes, they develop without diapause. A control method would consist of a "photoflash" treatment. During the nights of September or October the larvae should be illuminated from 11,30 to 12 p. m. and from 3 to 3,30 a.m. by using reflectors of a car or tractor. These short light impulses would prevent the larval diapause and stimulate the development of the imagines in the autumn. The oviposition on this generation would, however, be unsuccessful on the senescent rape leaves and lead to substantial decrease in population density.

#59

ECONOMIC CONSIDERATIONS OF INSECT PEST CONTROL IN SOYBEAN PRODUCTION IN JAPAN. O. Mochida and A. Kikuchi (Natl Agric Res Centre, Ibaraki-ken, Tukuba-si, Kan'nondai, 305 JAPAN)

More than 300 species of insects, nematodes, slugs, mites, etc. are recorded as pests on soybean in Japan. No application of insecticides frequently produced no yield, especially in western part of Japan. Podborers, stinkbugs, Spodoptera litura (Lep., Noctuidae), and nematodes are serious pests. No strong resistant cultivar to such pests is present with a few exceptions to the soybean cyst nematode. Frequency of insecticide application depends on the intensity of damage due to insect pest situations. Most farmers do not apply insecticides more than 3/4 times because of shortage of labour, high labour cost, and low price of soybean; less return.

These be presented.

#60

PROSPECTS FOR A CONTROL STRATEGY AGAINST THE CORN STALK BORER, SESAMIA NONAGRIOIDES, WITH EMPHASIS ON THE USE OF BIOCONTROL AGENTS. John A. Tsitsipis, M. P. Alexandri (Faculty of Crop and Animal Production, University of Thessalia, Pedion Areos, GR 383 34 Volos, Greece)

The corn stalk borer, Sesamia nonagrioides (Lef.) (Lepidoptera: Noctuidae), is an important pest of maize in countries around the mediterranean basin. Control by chemicals is difficult due to the nature of the crop (high and dense plantation) and the biology of the insect (eggs and most of larval instars protected). Biological control agents offer possibilities for the population suppression of the pest. The egg parasitoid Telenomus busseolae (Hymenoptera: Scelionidae) has been found to parasitise up to half of the eggs of the borer in the area of Istiaea, Greece. It is considered suitable for biocontrol since it has a long survival, a good reproductive potential (80 eggs/female), a presumbly good searching ability and it can be readily reared in the lab on S. nonagrioides eggs. The latter can be efficiently reared on an artifical larval diet. A control stategy could include: a) use of released egg parasitoids supplemented by the activity of the natural larval parasite Lydella thompsoni (Diptera, Tachinidae) occuring in maize-fields adjacent to hygrobiotopes. b) timely application of low toxicity pesticides and/or biopesticides determined by population monitoring with pheromone traps, if needed.

#61

THE REGULARITY AND INTEGRATED CONTROL OF *CEPHUS FUMIPENNIS* EVERSMANNS. Xu Peihe (Qinghai Academy of Agriculture and Forestry, Xining, Qinghai 810016, China)

Teh *Cephus fumipennis* Eversmanns, whose damages of the stems of spring wheat were 10-30%. The rates of loss were recorded by 5-10% on the average.

The starting development temperature of pupa calculated during the experiment was 3.66°C and its valid accumulative temperature is 333.33 day/degrees. The spatial distributional pattern of larva is Negative Binoinal.

The principal techiques used in the IPM programme were: Malathion, Cypermethion, Fenvalerate, Decamethrin pesticide spraying recorded as over 85% mortality; simutaeously, cultural control practices such as early harvesting, low cutting wheat stems, rolled husking, collectable the wheat stubbles, specially deep ploughing and turning the soil, conservation and protection of the natural enemies to control pest insects and the pest-resistant wheat species may choose plantable. The natural enemies of larvae of the species are chiefly *Collyria calcitrator* Grav., Ichneumoridae and *Microbracon terebella* Wesm, Braconidae.

#62

THE TECHNICAL SYSTEM OF WHEAT IPM IN HUANGHUAIHAI WHEAT REGION. Han-xiang Ni, Guang-bo Li, Yu-yuan Guo (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Since the eighties, research on wheat pest control in China has been advanced from IPM on a individual pest basis toward an IPM system on a multi-insect/disease basis, i.e. several key insects and diseases of wheat were taken into account as controlling objects. With this purpose, the wheat field was considered as a specific ecosystem. The population dynamics, monitoring and forecasting, action thresholds and key control techniques (including agronomic, chemical and biological control) and so forth were studied profoundly and systematically in Huanghuaihai wheat region, which is the biggest wheat growing area in China. The tactics of integrated control system were designed as follows: using resistant varieties to control stripe rust; macroscopic regulation, protection and utilization of natural enemies to deal with wheat aphids and oriental army worm; integrating chemical control with resistant varieties for controlling powdery mildew and wheat midge. A three-year demonstration implemented with this IPM system within 4,000 ha area was accomplished and further extended over ca. 33,333.3 ha of wheat fields. and the technical coverage area was up to 333,333.3 ha. In these area, significant economic, social and ecological benefits were obtained.

#63

STUDIES ON THE RESISTANCE MECHANISM OF WHEAT TO WHEAT MIDGE. Hong-jian Ding, Yu-yuan Guo (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Field experiments, biochemical and histological analyses on the resistance of 85 wheat varieties and lines to wheat midge Sitodiplosis mosellana Géhin were conducted. Path analysis, principal component analysis and stepwise regression analysis and so forth were used to determine the possible factors contributed to midge resistance; and a multi-factorial regression equation of larvae/ear depended on these main factors was developed. The results showed that the midge resistance of wheat was multi-stratiform and synthetical, i.e. there was a series of preventive or suppressive actions of wheat plant occurred in the ovipositing, hatching, invading or feeding processes, constituting the miscellaneous resistances to this insect pest. The non-preference effects, including the more advanced or postponed earing time than the occurrence peak of adults, the included angle between awn and axle of ear, and the shorter duration between earing to flowering, etc., significantly suppressed the oviposition behavior of wheat midges; the mechanical effects, a peculiar kind of resistance to wheat midge, including the good fitness of outer and inner glumes, the dense and strong margin hair of inner glume, the larger broadness of spikelet, and the included angle between spikelet and axle of ear, prevented the hatching of eggs and invading of larvae; the anti-biosis effects, including the more tannin and amino acid contents in immature kernel, suppressed the development and damage of larvae; and the tolerance effects can also reduced the loss.

#64

EFFECT OF TEMPERATURE-MOISTURE COMBINATION ON THE PUPATION AND ADULT EMERGECE OF SITODIPLOSIS MOSELLANA GEHIN. Chudao Yin, Meiquan Ji (Department of Plant Protection, Anhui Agricultural College, Hefei 230036, China)

The pupation of active larvae and the emergence of adults of sitodiplosis mosellana required an averge daily roomtemperature of 19.1°C and a corresponing soil moisture of 17-25%, with the most suitable range of 22-23%. When the soil moisture was satisfactory (about 20%), the temperature at 22°C was favorable. Below 20°C or above 24°C, the rate of larvae pupation and adult emergece apparemtly dropped down. No pupation was found at any temperature except the soil moisture was 10%. The highest and lowest rates of pupation were at 21°C—20% and 23°C—25%, respectively. As for the effect of temperature-moisture combination on the adult emergece, similar result was obtained. However, there were usually some diapausing larvae, which could not pupate or emerge, in each treatment, among them, the hightest rate of diapausing larvae was 10% at soil moisture. The effect of different temperatures, temperate-moisture combination on pupation and diapause of active larvae were not significantly different, but the effect of different soil moisture was very significant indicating that soil moisture was the main effective factor.

#65

A PROGRAM OF INTEGRATED PROTECTION ON THE WINTER WHEAT AGAINST PEST ORGANISMS

M.P.Lesovoi, Ukrainian Plant Protection Institute, Kiev, Ukraine, USSR

It is known more 300 arthropod pest species on the winter wheat in the Ukraine. But only a few of them are serius pests.They are (in brackets,the number of species is shown) the following: Aphididae (3),Hemiptera (4),Thysanoptera (1),Carabidae (2), Scarabeidae (5),Elateridae (6),Alleculidae (2), Chrysomelidae (5),Tortricidae (1),Noctuidae (4), Cephidae (2),Diptera (4),Acarina (3). The system that includes the usage only pesticide treatments for control these pests has been in practice until now. It has led to unfavourable ecologic and hygienig events.Therefore,it has been developed the integrated system of winter wheat protection that includes the usage of resistant cultivars,evaluation of phytosanitary situation, and method of decision of advisability of pesticide treatments on the base of damage thresholds. This program allows to decrease half the rate of pesticide dispersion, and it is in accordance with standarts of ecological security.

#66

PEST MANAGEMENT OF SORGHUM STEM BORER CHILO PARTELLUS SWINHOE, IN THE STATE OF RAJASTHAN. Lalit Shyam Sharma, T.Hussain.(Department of Entomology,Rajasthan Agricultural University, Rajasthan College of Agriculture,Udaipur-313001 INDIA.)

Sorghum (Sorghum vulgare L.) is an important cereal and forage crop of Rajasthan state. The crop is being infested severely by several insects including stem borer Chilo partellus (Swinhoe). The trials were carried out against stem borer during the rainy season (July-October) 1990. The field experiment was laid out in Randomised Block Design replicated three times. The treatments were carbofuran 3 G applied in plant whorls on 25th and 35th day after germination @ 8 & 10 kg/h respectively. Spray formulation of fenvalerate 20 EC (0.02%), cypermethrin 10 EC (0.01%) and endosulfan 35 EC (0.05%) were given on 25th and 35th day after germination. The results indicate that carbofuran 3 G gave minimum dead heart (3.06%) and maximum yield 71.6 q/h. Fenvalerate 20 EC exhibited 5.59% dead heart and the grain yield was 66.76 q/h while in control (untreated) the dead heart was 12.29% and the grain yield 35.02 q/h was recorded.

#67

MALADRA SP. IN YUNNAN. Shu-yun Xu (Tobacco Research Institue of Yunnan Province, Yu Xi City 653100, Yunnan, China)

Maladra sp. is a major injurious insect to tobacco in Yunnan It is widespread, infesting 2000000 mu of Yunnan's 3500000 mu tobacco fields. Its adult eats tobacco leaves, leaving on them large holes and gaps. The adult insect hides during the day and comes out to seek food in the evening. In a heavily infested field several or even a dozen adults can be found on one tobacco plant. June and July is the mest injurious period, during which they also mate and lay eggs.

Prevention and control: 1. clearing of weeds from the fields; 2. manual killing with the hand-light at dusk; 3. chemical controlling with organic phosphate insecticide etc.

#68

STUDY ON THE OCCURRENCE REGULARITY AND THE PREDICTION TECHNIQUE OF SOYBEAN POD BORER. Chengyu Gu, Yanchun Liang (Nenjiang Agricultural Institute, Heilongjiang Academy of Agricultural Sciences, Heilongjiang 161041, China)

The occurrence regularity of soybean pod borer, and the biology and ecology of this pest have been studied for many years. It was found that the population dynamics of this pest was influenced by natural enemies and meteorological factors. From the influence of natural enemy, the periodic change of population resulted. Based on the periodic population fluctuation, a mathematical model of super-long-term prediction of soybean pod borer population has been established as follows:

$$\bar{y}=8.09-6.19\cos 2\pi t/7+1.18\sin 2\pi t/7+0.743\cos 4\pi t/7+1.185\sin 4\pi t/7.$$

In the same time, according to the relationship between the population changes and the rainfall and the mean relative humidity in July, a mathematical model of extended-range forecast has been established as follows:

$$\bar{y}=0.102x_1+0.55x_2+0.55x_1x_2.$$

The computer progeam for super-long-range and middle-term prediction of the population of this pest were drawn up. The prediction model already actually guided the control of this pest in a large area. It was proved to be accurate, reliable, simple and convenient.

#69

STUDIES ON THE GRANULAR INSECTICIDES "SHA MIN LING NO. 1" FOR THE INTEGRATED CONTROL OF CORN INSECTS. Yi-fen Xin (DEPT. of Pl. Prot., Shenyang Agricultural University, Shenyang 110161, China)

For the sake of searching a high efficient and with a broad spectrum of insecticide, especially good for the most destructive main insects in the corn, such as the asiatic corn borer-Ostrinia furnacalis, the army worn of the second generation - Mythmna separata, and corn aphids Rhopalosiphun maidis, and this insecticide must not cost much. The authors carried on this researching item from 1983 to 1989 and have got very marked results.

Through the research, we have understand the happening regulations of these three insects, and a kind of new insecticide has been made and put to field extension. This new insecticide is "Sha min ling No.1" a granular insecticide for killing the insects on corn plants, especially effective to corn borer.

Only once scattered in the corn fields, the Sha Min Ling no.1 granular not only extrenely efficient to asiatic corn borer and army worm, but also has certain restrictions to corn aphids. It could save chemicles up to 2/3 in the corn field, compared with certain general chemicles and methods. Further, it had no harm to those insects parasites. Right now, about 300 thousand hectares have got very nice efficiency, and much more accepted and liked by the farmers.

#70

THE STUDY ON THE BIONOMICS OF PLEONOMUS CANALICULATUS FALDERMAN IN WHEAT FIELDS AND ITS NEW CONTROLLABLE TECHNOLOGY. Shi-hong Zhu, Sun Xun(Agricultural Research Institute of Tangshan, Tangshan 063001, China)

The bionomics of Pleonomus canaliculatus Falderman in wheat fields and its chemical control with 5 organophosphorus insecticides including granules of phorate and emulsion of phoxim were investigated. The technological indices including the damage characteristics of wheat by the pest in spring, optimum periods of control and the quantity of effective insecticides and their application methods were found out, and field application in a total area covering over 66.7 thousand ha was carried out in Tangshan, Langfang, Baoding and other regions with an effectiveness over 95%.

#71

THE OCCURRENCE OF METOPOLOPHIUM ALBIDUM HILLE RIS LAMBERS AND ITS INTEGRATED CONTROL IN TIBET. Hanyuan Yang, Baohai Wang (Tibet Institute of Agricultural Sciences, Lhasa 850000, China)

Metopolophium albidum Hille Ris Lambers is the major pest insect of the naked barley and wheat in Tibet, which occurs 13-15 generations a year in Lhasa and average of 11-13 generations among the whole Tibet. The nymphal aphid has 4 stadia, with the adult giving birth of 50-70 nymphs. The damage peak happens in middle and last part of July. The aphid's generation effective accumulative temperature ($K\pm SK$) is $124.59\pm10.6^{\circ}C$ day and its development critical temperature ($C\pm Sc$) is $4.6\pm0.93^{\circ}C$. Under the systematic studies, the integrated control strategy with the agricultural and chemical control being major methods is proposed and the damage of the aphid to cereal crop is decreased to the economic threshold and the excellent economical and social effects are obtained.

#72

ON GRAMINE OF BARLEY AND RESISTANCE TO APHIDS --- ANALYSIS WITH EDTA METHOD. Hideya Yoshida, Hisaaki Tsumuki (Lab. of Biol. Communication, Res. Institut for Bioresource, Univ. Okayama, Kurashiki 710, JAPAN)

Gramine, a kind of indole alkaroids, is known to play important roles in resistant mechanisms of barley to aphids. Negative correlation between gramine content of barley leaves and the number of infesting aphids has been found using many varieties including cultivars and wild types in field observations. Gramine decreases survivals of aphids reared on artificial diet containing it. These facts suggest that gramine function as resistant factor in barley leaves.

On the other hand, seedlings of barley contain much more gramine than the grown plants and aphids can be reared well on seedlings. In view of the plant stage, there seems no good correlation between gramine content and resistance to aphids.

To resolve the "discrepancy", we should know the localization of gramine in barley tissues and make the function of gramine in resistance clear. We prepared samples of phloem sup or their alternatives by the methods of stylectomy or EDTA (ethylenediaminetetraacetic acid) exudates. Preliminary results indicate that gramine maybe present in phloem sup in barley seedlings.

In this paper, we will estimate the localization and discuss about the mechanisms of resistance with gramine.

#73

STUDIES ON FEATURES OF RSV-CARRING BY LAODELPHAX STRIALLUS (FALLEN) AND ITS CONTROL . Yu-bing Liu (Institute of Plant Protection, Yunnan Academy of Agriculture Science, Kunming 650205, China)

Rice Stripe Virus (RSV) has caused great loss in single-crop rice regiions of Yunnan Province, in this paper the biology of its vector, small brown planthopper (Laodelphax striallus) with 4-7 generations annually, has been studed.

According to occurrence features of hopper, the rice planting regions could be divided into three types: 1. Wheat-main-crop region: in this region there is about 85% arable area for wheat, on which first generation of L. strallus feeds after winter, then migrates into rice seedling bed reaching to 667—2000 hoppers per ha, and the gluttonous stage lasts 25-30 days. 2. Faba-main-crop region: it includes about 85% arable area for early faba bean cultivation, where population of hoppers is much lower (only 67-133/ha), but much higher rate of RSV-Carring than that in 1, and with gluttonous stage 10-20 days. 3. Wheat-faba region: the hopper migrates into rice seedling bed reaching to 133-207 hoppers/ha, and the gluttonous stage lasts 15-20 days. The corresponding controlling measures could be taken according to these features.

#74

STUDY ON THE COMPUTER-AIDED FORECASTING NETWORK FOR THE RICE INSECT PESTS AND DISEASES (I)--DESIGNATION OF NETWORK SYSTEM. Bo Liu, Hao-guan Liu, Wen-Yang Zhang, Ping Li, Xiao-chuang Song(Institute of Plant Protection, Fujian Academy of Agricultural science, Fuzhou, 350013, China)

The present paper is one of the serial papers on the computer-aided forecasting network for the rice insect pests and diseases.The forecast entity models of the rice pests and diseases were analysed. The hierarchy division of the network and the configuration of the computer hardware and the communication devices were suggested.The entity model of the data base for the pests and diseases were discussed. The designation method of the data base structures and files were worked out. The functionsof the software of the network were divided into 4 parts.1.the data base management, 2. the forecasting analysis system, 3. the forecasting consultsystem and 4. the communication service system. The network has been successfully peocessed in manping prefecture,Fujian province.

#75

A POSSIBLE RELATIONSHIP BETWEEN OUTBREAKS OF THE BROWN PLANTHOPPER IN JAPAN AND EL NINO PHENOMENON. Masahiko MORISHITA (Wakayama Agricultural Experiment Station, Kishigawa-cho, Wakayama 640-04, Japan)

Of the thirteen outbreaks of the brown planthopper, Nilaparvata lugens Stal, occured in Japan during 1890-1989, eleven outbreaks occured in the next years of ENSO(El Nino and Southern Oscillation) events. This fact suggests that some climatic changes associated with ENSO events accelerated the population increase of N. lugens. South-east Asia, in which N. lugens multiply all year round, has less rainfall in the ENSO years. It is possible, therefore, that changes in precipitation pattern associated with ENSO events affects the population fluctuation of N. lugens. The mechanism how ENSO events affect the outbreaks of N. lugens in Japan still remained unsolved. Irrespective of the mechanism, the present result may be applied to predict outbreaks of N. lugens in Japan with attention to ENSO events.

#76

STUDIES ON THE COMPENSATIVE CAPACITY AND LOSS OF TILLERING STAGE RICE BY CHILO SUPPRESSALIS. Hou-guo Qin, (Institute of Plant Protection, Jiangxi Academy of Agricultural Sciences, Nanchang 330200, China),You-fu Xie (Fengcheng Popularization Center for Agricultural Technology, Fengcheng 331100, China)

The loss compensation and yield loss caused by rice stem borer(Chilo suppressalis Walker) at tillering stage were studied during 1989-1990.Results showed that, the compensative capacity and yield loss of the early rice infected by stem borer were significantly greater than those of the late rice,moreover, those at early tillering stage were much higher than at late tillering stage, and hybrid rice were much higher than common rice. The healthy rice plants surrounding a dead-heart group appeared to have partly compensation for loss.The compensation rate of effective panicles were 1.9-5.4% for early rice, and 3.76-6.25% for late rice. The compensation rate of yield loss were 2.58-4.94% for early rice, and 2.16-2.94% for late rice.

#77

STUDIES ON INSECT-RESISTANCE MECHANISM AFTER APPLYED BY SILICON IN RICE. Shao-fan Zhou, Gen Li, Zi-deng Peng (Zhongkai Agrotechnical College, Guangzhou, 510255, China) Bing-yao Yong (South China Agricultural University, Guangzhou510642, China)

The structures of rice leaves and leaf sheathes collected from the plants treated with and without silicon were examined by means of scanning electron microscope. It was found that the particles of silicon accumulated in the surface of epiderm and subepiderm of treated leaves were thicker and bigger. The silicous cells arranged with a pair on the surface of leaf vein appeared flat and close and one pair more than those of untreated plants every 70 nm under the field of vision. The total thickness of the epidermic outer cell wall including silicous layer and corneous layer increased by 0.6-0.7 nm. The cell wall of thick-walled cells out vascular bundles of leaf vein thickened and the number of the cells increased after silicon treatment. The changes of structure of leaf sheathes was similar to that of leaves. In addition, the population density of some pests such as rice leaf-roller and brown rice planthopper etc. decreased by 50-60% in silicon treated areas.It seems that the changes of anatomic structures of leaves and leaf sheathes after applyed by silicon is the main insect-resistance mechanism.

#78

RELATIONSHIP BETWEEN POPULATION INCREASE OF *SOGATELLA FURCIFERA* AND PLANTING AREA EXPANSION OF SUSCEPTIBLE HYBRID RICE. Guowen Hu, Jian Tan, Jufa Ma (China National Rice Research Institute, Hangzhou 310006, China), Jinyi Tang, Guichun Ma (National Forecasting Station of Crop Pests, Beijing 100026, China)

Since the 1980's, population increase of *S. furcifera* has trended towards outbreaks almost every year. There are many factors causing the outbreaks, for instance, increase of *S. furcifera* migrating from abroad, increasing application of nitrogen fertilizers and changes of cultural system. Growing plantation of susceptible rice hybrids (upto 40% of rice planting areas) provided good food source and environment for *S. furcifera*, resulting in population increase.

Hybrid rice Shanyou 2 was released in 1976. From then on, Shanyou 6, Shanyou 63, Shanyou 64 and Shanyou 46 replaced subsequently the former hybrids, most resistant to *Nilaparvata lugens* and susceptible to *S. furcifera*. More brachypters emerged, fecundity and egg hatchability were higher, population increased 1/3 time more on hybrids than on cultivars. *S. furcifera* multiplied one more generation on the hybrids planted in early season in South China than on the cultivars so as to increase time and number of emigrating *S. furcifera* and result in significant increase of time and number of *S. furcifera* migrating to rice growing areas along and above Yangtze River.

#79

EVALUATION OF ANTIBIOSIS EFFECT ON NILAPARVATA LUGENS (BPH) IN TWO RICE VARIETIES. Liang-you Zhang, Jung-tsung Wu, Xiu-qing Yang (South China Agricultural University, Guangzhou, 510642, China)

The resistance of "Hong-Yuan" and "Tainuo-Xuan" variety to BPH was evaluated as follows:

(1) The weight of honeydewexcreted and adults and adults fed on above two varieties lighter than those on susceptible TN1. The number of eggs deposited and adults emerged, nymphal survival (%) on these two varieties was less than that on TN1. This results showed that the varieties had antibiosis effect on the BPH.

(2) The population trend index of TN1 was 562.8, Tainuo-Xuan was 70.2, Hong-Yuan was 68.8 and resistant variety Mudgo was 17.3.

(3) The intrinsic control rate of Tainuo-Xuan, Hong-Yuan and Mudgo was 0.8752, 0.8778 and 0.9693 respectively.

#80

MATHEMATICAL CLASSIFICATION METHOD OF VARIETAL RESISTANCE IN RICE TO THE WHITEBACKED PLANTHOPPER, *SOGATELLA FURCIFERA*. Jian Tan, Guowen Hu, Jufa Ma, Xichun Cheng (China National Rice Research Institute, Hangzhou 310006, China)

The present paper describes a classification method of varietal resistance in rice to *S. furcifera* based on the mathematical analysis of the behavioural and physiological responses of the insect to 64 varieties from China and abroad. On the basis of data normalisation, four resistance indexes (nymph survival, population increase, egg hatchability and honeydew excretion) were analyzed using principal component analysis, indicating that nymph survival is most important factor in varietal resistance. For the comprehensive evaluation of varietal resistance, original data were weighted from the results of principal component analysis and analyzed using hierarchical clustering method; 64 varieties were categorised as 7 groups. Then the results were confirmed by the analysis of ISODATA clustering method. Group I and II include respectively 13 (Ptb33, N22, Rathu Heenati, IR64) and 11 (HA79317-7, Bairizao, Nabeshi, Chuanmi 2) resistant varieties, recommending for plant breeding materials and direct use in rice production. Group VI and VII comprise 9 (TN1, Jiaolu) and 4 (8604) susceptible varieties, respectively. Group III, IV and V containing 35 varieties were moderately resistant or susceptible.

#81

INTEGRATED METHOD FOR RICE PEST CONTROL IN THE RED RIVER DELTA OF NORTHERN VIETNAM. Pham Binh Quyen (Faculty of Biology, University of Hanoi, VIETNAM)

Generally in Vietnam and particularly in the Red River Delta, mistakes made by chemical-used methods for rice pest control have become more and more serious when modern farming techniques are applied to expand cultivated land for new rice varieties and to increase crops. Consequently environmental quality is being degraded, causing the increasing diseases and crop loss. Many rice pests which were not much devastating before have recently been the major destructive forces such as Nilaparvata lugent, Cnaphalocrosis medinalis and Leptocorisa acuta.

To overcome the difficulties, an intergrated method for rice pest control has been studied and efficiently applied to production in the Red River Delta.

#82

BIOLOGY OF THE CHIRONOMIDAE (DIPTERA) IN PADDY FIELDS. Kôji Yano (Laboratory of Applied Entomology, Faculty of Agriculture, Yamaguchi University, Yamaguchi 753, Japan)

Chironomidae, the most diverse insect group in the paddy field ecosystem which are important as prey of various predators, were studied for IPM in Yamaguchi, Japan.

Development: Optimum conditions for larval development of several dominant species were generally as follows: 30°C temperature, 20 mg/day/100 larvae of food, low rearing density (0.9 larvae/cm²) for more ovarian eggs and medium density (3.5 larvae/cm²) for higher percentage emergence.

Resistance to drought and high temperature: Larvae of Glyptotendipes tokunagai were tolerant for about ten days to dry soil with 10% water content, suggesting substantial resistance to varying paddy water conditions. Development was arrested in higher water temperature above around 35°C.

Population density: About 5,000 larvae/m²(25,000/m²/5 generations) of Chironomus flaviplumus would be able to develop if calculated optimum space were available. About 15,000 earlier instar larvae/m²/5 generations or 7,000 adults/m²/5 generations are estimated to occur.

Seasonal abundance: Large populations occurred after flooding (June-July), and a lower number was then seen until harvest. Several dominant species underwent three to five or more generations during the cultivation period.

#83

A STUDY ON THE INFESTATION OF COTTON PESTS COMPLEX AND THEIR LNTERACTION. Wang Ruiqi , Zhang Shifu , Fan Xiaoxian , Xiong Yingqing (Plant Protection Institute, Hubei Academy of Agricultural Sciences Wuhan 430064 China)

By means of the two-year inoculation of insect pests in cages, the impact of insect pests complex [Pectinophora gossypiella (Saunders), Tetrangchus cinnabarinus (Boisduval) , Syllepta derogata Fabricius, Empoasca biguttula (Ishiha), Aphis gossypii Glover] on cotton yield, yield components and quality were quantitively described by path analysis respectively. Their interaction were disclosed. There are main results below.

With the pests complex infestating, each species influenced cotton yield not only by direct effects but also by indirect effects-positive or minus interaction. For example, between the species with sucking mouthparts and between the species with chewing mouthparts and the species feeding on cotton fruits, the positive interations were shown. But between the chewing-mouthparts species feeding on leaves and the species with sucking mouthparts, the minus interaction were shown.

Among the insect pests complex, there were certainly 1-2 species that were primary factors influencing cotton yield or quality. They had very large direct effects and the others did very small direct effects. The species showing the largest direct effects on cotton had the largest indirect effects. The species showing small direct effects had small indirect effects.

#84

THE PRELIMINARY STUDY ON THE BEST APPLICATION OF NITROGEN FERTILIZER OF THE MIDDLE YIELD OF COTTON Shun Liu, Yi-zhi Wang (Department of Plant Protection; Hebei Agricultural University; Baoding, 071001 China)

#85

STUDIES ON PINK BOLLWORM CONTROL BY EXCISING EARLYSQUARES. Rong-hai Chen(Plant Protection Station of Anqing. Anqing. Anhui 246001. China)

The damage of the pink bollworm had a close correlationship with the number of squares during the first generation. Excising early squares suppressed boll-boring insects. and bloom infestation was reduced by 70. 5-82. 6% . Whereas. chemical control of first generation larvae decreased bloom infestation by only 37. 10% . The damage caused by the second generation was decreased as squares excised increased. While the squares appeared before July 10th were excised, and insecticides were not applied generation. the losses remained under economic injury level. Excising squares increased fruit joint and boll number. In a large area filed survey after extending the techniques. the average boll infestation was 46. 65% and tunnals in boll produced by pink bollworm larvae were 0.685 per boll. In control area where squares were not excised and pyrethroid plus chlorodimeform was applied 3 times the average boll infestation was 55.95% and tunnals were 0.78 per boll.

#86

EGG NUMBER PREDICTING TECHNIQUE OF 2ND GENERATION PINK BOLLWORM IN AREAS ALONG HUAIHE RIVER. Guang-ci Bao (Science and Technology Committe of Shouxian County, Shouxian. Anhui 234100. China) . Hou-yong Yan (Plant Protection Station of Shouxian County, Shouxian. Anhui 234100. China)

Based on the correlation analysis of the egg number of the 1st generation pink bollworm in Shouxian county from 1965 to 1990, to the ratio of infested flower buds, the ratio of infested flowers, RH. sunlight hours, rainfall. temperature. total solar radiation. evaporation, atmosphere pressure from June to July, of which 3 factors were chosen at 5% and 1% level tests: (1) the ratio of infested flowers (x_1) during the 1st generation; (2) RH (X_2) of late June; (3) humidity-radiation index(x_3) (sunlight hours/RH) . The egg number (Y) 2nd generation worm were correlated to the 3 factors in the following forms:

$\hat{Y}_1$=-25.79053+28.060612x_1+(-3.6399418)x_2+24.56817x_3± 75.126035

$\hat{Y}_2$=-120.69251+9.4683135x_1+(-1.5261186)x_2+206.32579x_3± 87.129099

The validity of the formulas was tested justified.

#87

A STUDY ON THE OCCURRENCE AND THE CONTROLLING TECHNIQUE OF COTTON PESTS IN WUHAN. Tian-bao Huang, Jian-hua Li (Institute of Agriculture, Agricultural Reclamation Management Bureau of the East and West Lake in Wuhan, Wuhan 430040, China)

In the cotton area of Wuhan, four pests were main cotton pests, such as Pectinophora gossypiella, Heliothis armigera, Tetranychus urticae and Aphis gossypii. The serious harming period of cotton aphid occurred in the seedling stage of cotton. Cotton red spider endangered gravely during the years of high temperature and dry. Cotton bollworm was the frequently-occurring type of the third and forth generation. And the occurring quantity of pink of bollworm had been increasing generation by generation. In this paper, it was reported that the key techniques of controlling cotton pests, such as the optimum structure of planting crops, using the natural enemies as far as possible, timely applying pesticide according to the resistant varieties to the manifold cotton pests.

#88

APPLICATION OF PROGRESSIVELY DISCRIMINATING ANALYSIS IN THE RESISTANCE IDENTIFICATION OF COTTON VARIETIES TO PINK BOLL-WORM. Chao-liang Lei, Chang-zhen Zhong, Liang-bing Zong, Xiao-hua Wen (Department of Plant Protection, Huazhong Agricultural University, Wuhan 430070, China)

Thirteen resistant identified indexes of 36 cotton varieties to pink bool-worm have been studied with the method of progressively discriminating analysis. Three resistant indexes such as the numbers of living larvae percent bolls(x_7), the numbers of the third generation egg percent stems(x_{11}) and the numbers of invading hole per boll(x_{13}) were screened from 13 resistant indexes. Five discriminating formulae were built on the besis of the three indexes. They are as follows: (1) High resistance: F1= -1.7918-18.8579+0.5120x_7 +1. 0279x10^{-3} x_{11} +2.0321x_{13} ; (2) Resistance: F2=-0.8109-31.7445+ 0.7195x_7 +1.6321x10^{-3} x_{11} + 2.3207x_{13}; (3) Middle resistance: F3= -1.5041-52.3447+ 0.9844x_7 + 2.1339x10^{-3} x_{11}+ 2.6874x_{13}; (4) Susceptibility: F4= - 2.8904-98.3229+1.3353x_7+ 1.5106x$10^{-3}$$x_{11}$ + 4.4132x_{13} ; (5) High susceptibility: F5= -2.1972-127.0273+1.6945x_7 + 1.5206x$10^{-3}$$x_{11}$+ 4.0641$x_{13}$. The accurate rate of return discrimination of the formulae was above 91.70 percent, and the accurate rate of remain discrimination was above 90.90 percent. There was only one level error for mistaken discriminating varieties.

#89

THE POPULATION DYNAMICS AND CONTROL OF THE PEAR CURCULIO (*RHYNCHITES FOVEIPENNIS* FAIMARE IN LIANGSHAN

Guo Yunhua (Xichang Agricultural College, Sichuan 615013, China), Yang Minfu (Agricultural Bureau of Xide county, Sichuan China), Wu Weixi (Agricultural post of Xichang, Sichuan, China)

Serious damage has been caused by the pear curcudio (*Rhynchites foveipennis* Fairmare) to apples and pears in recent year in Langshan, Sihuan province. Studies on the bionomics and control measures have been carried out since 1986 in Xide county. The studies have shown that curculio finished one genention in a year, and occassionally lasted for two years. The larvae, pupae and adults all can overwinter. The adults usualy begin to come out of soil at 15°C in rainy days in spring and spred quickly after heavy rains. The incubation period of the eggs lasted from 4 to 10 days. The larvae molted twice. The width of head capsule is about 0.6 to 0.7mm for first instar and 1.3 to 1.4mm for the second. The larvae bore fruits for at least 14 days. When temperature in autumn falls below 20 , they started to pupate. The pupate stage lasted for about one month. Control measures such as cultivating around the tree in winter or spraying the crown of the tree with insecticides before the adults come out of soil and cleaning up all the fallen fruits once every 10 days have been proved to be fruitful.

#90

ESTABLISHMENT OF *TOXOPTERA CITRICIDUS* (HOMOPTERA: APHIDIDAE) IN CENTRAL AMERICA. R.K. Yokomi (USDA, ARS Hort. Res. Lab., Orlando, FL 32803, USA), R. Lastra (CATIE, Turrialba, COSTA RICA), S.M. Garnsey (USDA, ARS Hort. Res. Lab., Orlando, FL 32803, USA), R.F. Lee, C.L. Niblett (Dept. Plant Path., Univ. Florida, Gainesville, FL 32611, USA), M. Rocha-Peña (INIFAP-SARH, Nuevo Leon, 67400 MEXICO)

A survey of citrus was conducted in September 1991 in selected commercial groves, nurseries, and dooryards throughout Central America and Mexico to determine the incidence of citrus tristeza virus (CTV) and the presence of its efficient aphid vector, *Toxoptera citricidus*. *T. citricidus* was established throughout Costa Rica and in southern Nicaragua. *T. citricidus* was previously reported in Panama. *T. citricidus* was not found in Honduras, El Salvador, Guatemala, Belize, or Mexico in this survey although it has been reported previously in Guatemala, Honduras, and El Salvador. CTV was generally found localized throughout Central America and natural spread is occurring. Decline-inducing CTV strains were detected in this survey. *T. citricidus* develops large populations on citrus and its alatae can rapidly spread CTV. Much of the citrus from Nicaragua north to the U.S. mainland is on the CTV-sensitive sour orange rootstock. CTV decline poses a significant problem to approximately 1 million acres of citrus in this region. The surveys should be continued to monitor this problem and a clean stock program should be implemented for this entire area.

#91

PHYSICAL CONTROL OF THE TARNISHED PLANT BUG IN STRAWBERRY PLANTATIONS BY ASPIRATION. Charles Vincent (Agriculture Canada, Research Station, 430 Boul. Gouin, Saint-Jean-sur-Richelieu, Que. Canada J3B 3E6), Pierre Lachance (BRA - MAPAQ, Bureau Régional 11, 91 Boul. St-Louis, St-Louis-de-France, Que. Canada G8T 1E5).

The tarnished plant bug, *Lygus lineolaris* P. de B. (Hemiptera: Miridae) is a major pest of strawberry plantation in Quebec, Canada. Adults and nymphs that feed on young fruit cause a decrease in yield and in fruit quality. Because few biocontrol tactics are available, the control of tarnished plant bug population rely chiefly on chemical control. Mounted on top of a tractor, Biovac is a giant aspirator that sucks insect pests. The insects are killed while passing through the turbine. Biovac was compared for two consecutive years in a strawberry plantation against Malathion (as a standard commercial practice) and a check sprayed with water. The action threshold used was 1.2 nymphs and adults, as estimated by gently tapping fruit trussess over a plastic pan. The results show that Biovac is a competitive alternative to Malathion to control tarnished plant bug populations in strawberry.

#92

PROBLEMS OF VECTOR INSECTS FOR JUJUBEWITCHES' BROOM DISEASE. Zhuo Wang, Ju-xin Sun (Shandong Institute of Pomology, Taian 271018, China)

Hishimonoides chinensis Anufriev and Hishimonus sellatus Uhler were demonstrated to be as the only two species of insect vectors for jujube witches' broom disease. The former male genitalia has a obvious parallel at the second ventrolateral protuberance. Domestic and foreign experiments showed pathogen (MLO) of jujube witches' broom disease and mulberry dwarf disease may be the same. The south limits of distribution are 32° 38′ north latitude for H. chinensis and 24° 44′ north latitute for H. sellatus respectively. However, the main jujubeproducing areas are all to the north of 32° 38′ north latitude. So if no H. chinensis distribute in that areas, H. sellatus may be the major vector of transferring disease. The disease is seldom found in the distinct of Zizyphus jujuba (Leling et al.) in Shandong. It is thought the disease is closely related to the species of insect vector and their numbers.

#93

FAUNA OF TIBET FRUIT TREE INSECTS. Shulin Li, Xutang Liu (Forestry bureau of Tibet, Lhasa 850000, China), Gangxi Zhang (Plant Protection and Quarantine Station of Tibet, Lhasa 850000, China)

Tibet insect of fruit tree ranges N 28-31.2° and E 86-98.7° and the altitute between 800m-4050m. The insect fauna can be divided into 5 districts on analysis of landform, vegetation, climat, soil and fruit tree species: 1. Chayu-Muotuo humid and hot district; 2. Linzhi-Bomi humid and warm district; 3. Lhasa- Shangnang semiarid and warm district; 4. Mt. Tengduan arid and hot district; 5. Xigaze arid and cool district. In each district, the community of insect composition has its own characters. It relates to the plateau special ecological conditions. Among 168 species of fruit tree insects registered, the alpine ones 44.7%, the widely distributed 45.6%, and the introductory 9.7%, respectively as Leptomias spp. Toaeospathins auriventris and Eriosoma lanigrum. The later one is harmful to apple production in Tibet. Insect list and management table are also included.

#94

RESPONSES OF THE FRUIT FLY Dacus spp. IN JACKFRUIT TREE TO METHYL EUGENOL AT BANDUNG AREA. Sastrodihardjo S., T. S. Syamsudin., A.D. Permana., Y.R. Gionar (Inter University Center-Life Sciences Ganesha 10 Bandung 40132, Indonesia).

Preliminary study in fruit fly controlling program had been held at Bandung area. Two Dacus species; D. dorsalis and D. umbrosus were respond by using Methyl eugenol traps from the jack fruit tree. The highest traps were found at the first day at one meter distance from the tree while the next days were decrease. The trapping method will be discused.

#95

CONTRIBUTION TO THE STUDY OF COCCINELLIDAE AND CHRYSOPIDAE ASSOCIATED WITH CITRUS AGROECOSYSTEMS IN PORTUGAL. J. C. FRANCO (Sec. Aut. Prot. Integrada, Ins. Sup. Agronomia, Tapada da Ajuda 1399 Lisboa Codex, Portugal), A. MAGRO, J. PASSOS-CARVALHO (Dep. Entomologia, Estação Agronómica Nacional, Qta. do Marquês, 2780 Oeiras, Portugal) & A. RAIMUNDO (Dep. Biologia, Universidade de Evora, Apartado 94, 7001 Evora Codex, Portugal)

Coccinellids and Chrysopids are important predators of citrus pests. Their role as agents of natural control must be preserved and stimulated in IPM programs on citrus groves. To achieve this aim it is necessary to identify the existing species of each group, study their relative importance and bioecology.

In this work the authors present and discuss preliminary data on the species complex, bioecology and monitoring of Coccinellids and Chrysopids associated with citrus agroecosystems in Portugal.

#96

FRUIT FLIES OF ECONOMIC IMPORTANCE OF THE GENUS *DACUS* IN GUANGZHOU AND NEARBY REGION. Guang-qin Liang, Wei Xu, Fan Liang (Guang Zhou Animal and Plant Quarantine Serviec, No.82, Zhan Qian Rd. Guangzhou, China)

There are three species of fruit flies of economic importance in Guangzhou. They are the oriental fruit fly, *Dacus dorsalis* Hendel, the melon fly, *Dacus cucurbitae* Coq., and the pumpkin fly, *Dacus tau* Wallker. The oriental fruit fly has a very wide host range, it apparently attacks all types of flesh fruits. The melon fly and the pumpkin fly seriously injure cucurbitaeceous plants. According to the survey in Guangzhou from 1980 to 1990, the oriental fruit fly does not occur every year. It seems to have intermissions. As to the melon fly and the pumpkin fly, the former has not been found during early 1980s in fixed-survey positions until 1987; the latter has been caught by Cuelure trap every year but the population of the melon fly was less than that of the pumpkin fly.

The results of monitoring after many years show that the occurring of the melon fly in Guangzhou reached a high population in some years and it was hard to find in some other years. The three species of economically important fruit flies in Guangzhou are not in their damage to crops serious. Because the farmers control them along with other insect pests in fields or in gardens. Thus the fruit flies do not injure crops seriously.

#97

STUDIES ON THE CITRUS WHITEFLY POPULATION DYNAMICS AND WITH THE INFLUENCE BY PESTICIDE. Yan-lin Zhang(Shanghai Qianwei Farm,Shanghai 201913,China) ,Zhi-yi Luo(Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025,China)

This paper reports the citrus whitefly life cycle and habits, life table data and field popolation dynamics as well as pesticide influences on them in Changxing island. The whitefly occurs three generations per year with the third generation nymph overwintering there. In each stage, the death rate of eggs and 4th instar nymph is the highest and the 2nd instar nymph is the lowest. The survival curve of population is subjected to the Weibull model type III. The field popolation dynamics data which characterised with aged structure show the quantitative and decline and influence by pesticide in field. Finally, the citrus whitefly population dynamics on privet tree is analysed as well. The roles of the citrus whitefly served as alternate foods by predacity mite (Amblyseius eharai) are also discussed.

#98

DEVELOPMENT OF THE WHITE-SPOTTED LONGICORN BEETLE, ANOPLOPHORA MALASIACA (THOMSON) (COLEOPTERA: CERAMBYCIDAE) IN CITRUS TREES. Ishizue Adachi (Okitsu Branch, Fruit Tree Research Station, Ministry of Agriculture, Forestry and Fisheries, Okitsu, Shimizu, Shizuoka 424-02, JAPAN)

A. malasiaca development from egg to adult emergence in citrus trees was examined in the laboratory at constant (20°C, 25°C and 30°C) and fluctuating temperatures. The latter simulates the natural fluctuation of temperature in the field, and has both circadian and annual fluctuations. By applying different temperature starting points in this annual fluctuation, differences in development in relation to different oviposition times could be examined. Survival rates of larvae were relatively high, except for 25°C and 30°C where all larvae died within a year. A. malasiaca required 1 or 2 years to complete a life cycle. The ratio of the 1-year type individuals increased with earlier oviposition time. Almost all larvae overwintered at 8th instar, and emerged as 1-year type adults the following June.

#99

DEVELOPMENT OF CITRUS MEALYBUG, PSEUDOCOCCUS CITRICULUS GREEN, AT THREE CONSTANT TEMPERATURES. Tomonori Arai (Okitsu Branch, Fruit Tree Research Station, Ministry of Agriculture, Forestry and Fisheries, Okitsu, Shimizu, Shizuoka 424-02, Japan)

Citrus mealybug is a common pest of citrus in Japan, feeding on shady parts of the citrus foliage and on fruits below the sepals. This insect can overwinter on citrus and causes economic damage, especially when the trees are growing under artificial conditions such as in a greenhouse. The honeydew excreted by this pest causes a sooty mold, resulting in reduction of the value of the fruit, and the trees are also damaged when heavily infested with the pest. P. citriculus females become adults after three larval instars and males after two larval instars and a cocoon pupal stage. Larvae were collected at the time of hatching and reared individually on citrus leaves. Periods of egg, larva, and preoviposition stages were studied at three constant temperatures under 16L:8D photoperiod. Growth rates and body sizes of larvae were measured, and fecundity of females was also determined at each temperature.

#100

STUDY ON THE BIOLOGICAL PROPERTIES AND MEASURES OF CONTROL OF BUZURA SUPRESSARIA GUENEE. Min-long Wang (Tea Research Institute, Xianlangguang Tea Company, Langxi County, Anhui Province 242131, China)

Buzura supressaria Guenee is a serious pest of crops. It finishes two generations within 1 year in Shizi Tea Region. It overwinters by pupa. A pile of ova are oviposited into the crevices of barks, into the slits of walls and electric wire post etc. or into the dead soil covering and weeds. Egg-stage is from 8 to 19 days. There are 6 instars in larval stage which take 25 to 39 days. Larva are aggregate on the comas of teas for before No. 4 instar, and move in tea tree group during 5-6 instar generally. The pupae stage is during 7 to 25 days. Adults copulate during nights just after eclosion, then oviposit the second day. Life of adult ranges between 4 and 10 days.

Larvae are often infected by NPV. So it results in viruses to spread. NPV acts as main suppress factors of the number of the pest. Telemonus sp. Parasitic flies are important natural enemies to the pest, too. Good control results to larva can been got by Phoxim or Deltamethrin. If they are utilized frequently, the pest bring in resistance easily. Dipterex and DDVP are only resultful to larva from 1 to 3 instar. Using NPV to control larva 1 to 4 instar by 3.0×10^{10}-4.5×10^{10} PIB/mu, control effect of 90-100% can been acquired; Mixed utilization of Buzura supressaria NPV and Ectropis obliqua NPV will result in better effect.

#101

POPULATION DYNAMICS OF PEST ARTHROPODS AND THEIR NATURAL ENEMIES IN A ORGANIC FARMING TEA FIELD: A CASE STUDY IN SUSTAINABLE AGRICULTURE. Jojiro Nishigaki (Faculty of Agriculture, Shizuoka University, Shizuoka 422, Japan)

Seasonal population dynamics of several tea pests such as mites, aphids, leafhoppers, thrips, leafroller moths, and their natural enemies such as spiders, green lacewings and parasitic wasps were investigated in the summer of 1985 in a organic farming tea field, where had been completely managed without chemical pesticides and fertilizers during nine years. The number of populations were estimated by using following methods : visual counting, light traps, sticky plates and tea branch jarring. The results were compared with those of a conventional managing tea field, where had been regularly used chemicals. On this investigation, it was found that 1) the fauna of the organic farming field still kept more naturality than that of the conventional managing field, 2) the number of pest populations of the organic farming field were lower and stable in general, 3) the important tea pests were rather abundant in the conventional managing field, 4) natural enemies which had not so strong dispersal ability, like spiders, were more abundant in the organic tea field. These facts indicated that in the organic farming tea field, the pest arthropods could had been practically controlled enough by natural enemies without any chemical control measure.

#102

A STUDY ON THE TRANSMISSION OF BANANA ROSTTE DWARF DISEASE BY STEPHANITIS TYPICUS DISTANT. Shao-fan Zhou, Xi-zhan Wu (Zhongkai Agrotechnical College, Guangzhou, 510225, China), Qian-cai Chang, Xian Yang, Yi-min Zhong (South China Agricultural University, Guangzhou, 510642, China)

The vecter of Banana Rostte Dwarf Disease was studied by means of biological tests and the examination under electron microscope. The results of our experiments showed that adults of Stephanitis typicus Distant after feeding on the diseased plants for 3-5 days and then transfered pathogen to the healthy ones could transmit the disease. The infection period was 2-4 days and the latent period was 3-32 days.

Enormous masses of MLO were observed in the salivary glands of S. typicus which had feeding on the infected plants under electron microscope. The pathogen was similer to that found in the sieve tubes of leaf vein of diseased plants. Thus further evidence was obtained proving that S. typicus is the vecter of Banana Rosette Dwarf Disease in Guangdong.

#103

REDUCED INCIDENCE OF LESSER PEACH TREE BORER, SYNANTHEDON PICTIPES, INFESTATIONS IN PEACH X ALMOND HYBRIDS.

Gary J. Puterka and Ralph Scorza (USDA-ARS, Appalachian Fruit Research Station, Kearneysville, West Virginia, 25430, U.S.A.)

We discovered that lesser peach tree borer (LPTB) damage was virtually nonexistent in 6-8 year old peach x almond hybrids grown in mixed variety orchards. To elucidate the reduced incidence of LPTB infestations, different peach and the peach x almond hybrids were given 25 mm diameter wounds. Half of the wounded trees were inoculated with Cytospora canker to determine its role in LPTB infestations. One month after wounding, counts on LPTB infested wounds were made and the degree of wound gumming was determined. Wound healing and secondary LPTB infestations were also determined the following year. No differences in percent infested wounds were found between the peach and the hybrids, or the Cytospora canker treated and untreated wounds. Apparently, LPTB can successfully infest and utilize hybrids as hosts. However, the hybrid's wounds gummed significantly less and wounds healed more rapidly than did those of peach. These two factors were probably responsible for the absence of LPTB infestations prior to the study because Cytospora canker and gummosis have been shown to facilitate LPTB infestations.

#104

SEQUENTIAL PROCESSES OF EUPYRENE-APYRENE SPERMATOGENESIS AND SPERMIOGENESIS IN BLACK CUTWORM (AGROTIS YPSILON) AND ORIENTIAL ARMYWORM (MYTHIMNA SEPARATA).

Lu Zhongjian* Wang Yinchang You Ziping (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014), (*Current address: Shanghai Animal and Plant Quarantine Service, Shanghai 200032)

Eupyrene-apyrene spermatogenesis and spermiogenesis in black cutworm [Agrotis ypsilon (Rottemberg)] and oriental armyworm [Mythimna separata (Walker)] were studied with modified Feulgen Smear Procedure. The results are summarized as follows: 1. Feulgen Smear Procedure gives good results in studying insect cystic spermatogenesis and spermiogenesis by light microscopy; 2. Eupyrene-Apyrene dichotomous spermatogenesis are both present in black cutworm and oriental armyworm, and the shift from eupyrene to apyrene occurs in the late 6th instar larvae; 3. Seven stages of eupyrene spermatogenesis and spermiogenesis could be identified as follows: spermatogonium cysts; primary spermatocyte cysts; secondary spermatocyte cysts; spermatid cysts; elongated spermatid cysts; developing sperm bundles; mature sperm bundles. While apyrene spermatogenesis and spermiogenesis consist of only five stages, i.e., spermatogonium cysts; spermatocyte cysts; spermatid cysts; developing sperm bundles; mature sperm bundles. 4. Each eupyrene-apyrene sperm cyst or bundle has a somewhat fixed shape, which differs between the two noctuid species. It is suggested in this paper that the sperm cysts especially their mature forms could be used in the taxonomy of these groups of insects.

#105

PRELIMARY STUDIES ON OCCURENCE AND CONTROL OF THE BEET ARMYWORM IN WUHAN.

Shu-xun Zhu, Feng Zou (Wuhan Institute of Vegetable, Wuhan 430065, China)

The beet armyworm, Laphygma exigua, is one of the most serious pest infesting the vegetable in Wuhan. It has seven generations per year, and passes over the winter by larve or pupa. The main impaired generations are the fifth and the sixth. The results of investigation show that (1) there is the possibility of long distant migrate for the beet armyworm, (2) the pest exists many host-plants, (3) the ability of scatter to it is very strong, (4) the ability of cold-resistant is very poor. It is little effective for the common pesticides to control the beet armyworm because the pest has produced the alternate resistance to the insecticides. This paper reports the results of harnessing the resistant pest with using growth-regulating substance of insect, Cascade, rotating and mixing many insecticides, reducing the quantity and the number of applying pesticides, etc..

#106

STUDIES ON OCCURRING PATTERN AND INTEGRATED CONTROL OF CEROPLASTES JAPONICUS.

Jing-jiang Lian (Wuhan Institute of Landscape and Gardening Sciences, Wuhan 430081, China)

Japanese wax scale (JWS), Ceroplastes japonicus Green, is a major scale insect on garden plants, particularly on roadside-planted tree Platanus orientalis and Bischofia polycarpa, It usually inhabits on excessive growing branch in the middle and low litter of tree canopy. In the north of the Yangtze River, it occurs 3 generations a year. After overwintering on 2-4 years branch with third instar female, it emerges and oviposits in June next year, when daily mean temperature is above 23℃.Heavy raining and early falling of leaves are the main mortality factors operating on JWS on roadside-planted trees durning ovipositing period, while it is natural enemies' effect on JWS on garden trees. The amount of oviposited eggs varies from tens to thousands with host and density. It is carried from one place to another by moving cars and walking men and reaches on a new plant with the help of air current. Result of integrated control over a extensive area indicated that pruning in winter may cause 50% to 80% decrease in overwintered JWS population and benefit natural enemies. In the late of heavy hatching period, careful application of Huabou (diluted 30 times), a pesticide without social effects of pullution, can result in 99% mortality on JWS. Desired effects can be also obtained with tree injection or spraying of oxidative dimethorate, but it can only be used in the sparse population area beacuse of its environmental pollution.

#107

PRIMARY STUDIES ON THE EFFECT OF INDUSTRIAL AIR POLUTION ON THE DISTRIBUTION OF SCALE INSECTS.

Jinmei Xia, Bigong Xu (Devision of Public Affairs, Shanghai Meishan Metallurgical Company, Nanjing 210000, China), Jinsuo Ding (Anhui Agricultural University, Hefei 230031, China)

In order to demonstrate the effect of industrial air polution on the distribution of scale insects, comparative studies had been carried out among three different natural regions: coking factory(1), steel mill(2) and residential quarter(3) in a industrial park. The results showed that there was obviously a reverse relationship between harmful gase content and the species of scale insects. The air content of SO_2 in the 3 regions was 0.0678, 0.0419 and 0.0255 mg/Nm^3 respectively. And that of CO was 0.805, 0.235 and 0.095. On the contrary, there were only 6 species of scale insects in region 1, 7 species in region 2, but 27 species in region 3. However, the species and density of host plants were allmost the same in different regions. And other air polution parameters mornitored showed little difference either. Therefore, the conclution was drawed that industrial air polution can affect the distribution of scale insects, which is mainly caused by increased air content of harmful gases such as SO_2 and CO.

#108

REGENERATION OF ROOT KNOT (*MELOIDOGYNE INCOGNITA* KOFOID AND WHITE) RESISTANT PLANTS THROUGH TISSUE CULTURE TECHNIQUES IN JUTE (*CORCHORUS OLITORIUS* L. VARIETY JRO-632).

P.K. Ghosh and A. Chatterjee (Centre of Advanced Study in Cell and Chromosome Research, Department of Botany, University of Calcutta, University College of Science, 35, Ballygunge Circular Road, Calcutta-700019, West Bengal, India)

The present paper deals with the induction and regeneration of root knot (*Meloidogyne incognita* Kofoid and White) resistant plants of callus tissue from in vitro system of jute (*Corchorus olitorius* L. variety JRO-632). Hypocotyl explants were cultured in both Murashige and Skoog's (MS) and Schenk and Hildebrandt's (SH) basal media supplemented with different growth regulators in definite concentrations. Callus growth was found better in MS basal medium than SH medium. For morphogenetic study the hypocotyl callus tissues were grown in medium containing different combinations and concentrations of auxins (NAA, IBA, IAA and 2,4-D used separately 0.1mg/L to 0.5mg/L) and cytokinins (BAP,Kn used separately 0.1mg/L, coconut milk 10-35% V/V). A simplified methods for morphogenesis of calli of *Corchorus olitorius* L. variety JRO-632 was standardized. These root knot resistant plants gives more fibre yield than the control plant and it is also superior quality.

#109

BIOLOGY AND TOXICITY OF BACILLUS THURINGIENSIS FROM SOILS IN CHINA. Rong-sen Li, Shun-ying Dai, Xiao-gang Li, Ying-chun Zhao and Chun-e Sun (Wuhan Institute of Virology, Academia Sinica, Wuhan 430071, Hubei, China)

130 isolates of Bacillus thuringiensis were isolated from soils in southwest, northwest, south and center of China. These isolates were belonged in 17 serotypes (H0, H3-8, H10, H13, H20-22, H24, H26-29) out of 29 serotypes of Bacillus thuringiensis. 9 species of insects in Lepidoptera, Coleoptera and Diptera were used for assay of δ-endotoxins. The morphology of cells, spores and parasporal crystals of all isolates was investigated under transmission and scanning electro-microscope. Proteins of δ-endotoxins from all isolates were analysed by rapid SDS-PAGE.

Most of bipyramid crystals with proteins of 130-140kD and bifrustrum-pyramid crystals with proteins of 50kD showed no toxicity or very low toxicity in larvae of Lepidoptera, Coleoptera and Diptera. All sorts of mosaic-bipyramid with both of 130-140 kD and 65-68kD proteins possesed very high toxicity to larvae of Lepidoptera including Noctuidae. Some crystals with forms of cube, polyhedron, globe or cup-like were effective to larvae of Coleoptera (Chrysomelidae, Bruchidae, etc.) and contained proteins of 35-74kD or proteins of 130-140kD and 34-68kD. Multi-shape crystals were very active to Prodenia litura and they were consisted of 130-138kD proteins.

#110

STUDIES ON THE BIONOMICS AND THE MANAGEMONT OF AULACASPIS CITRI CHEN Peng Yikun (Nanchong Agricultural ouetaral College, Nanchong. Sichuan 637102, China)

Aulacasps citri Chen is an important pest infesting citrus tree in sichuan province. It can complete development of 5 generations in a gear with a wide overlap of generations in which Sexual reproduction is dominatcd. The average fecundity is 196 egg per female. The mortalitg of hibernated female is 16.54%. The *main predator of the pests* are *Tefsimia emarginata* Chapin, *Crgptolaemus montrouzieri* Mulsant, *Pseudoscymnus kurohime* (Miyatoke) *Chilocorus kuwoanai* Silvstri, *C. nigritus* (Pahricius), *Chrysopa sinica*, *C. nigritus* (Fabricius), *C. shansiensis* Kuwayama etc. The main parasitoid is *Aphytus* sp. which caucsed 8.41-13.16% parasitism. *Aulacasps* citri can be controlled by erasing bryophyle and spraying omethoate in midde of March and midde of April.

#111

EFFECT OF PARASITISM BY Copidosoma bakeri ON CROP DAMAGE DYNAMICS OF THE ARMY CUTWORM J.R. Byers and D. Yu (Agriculture Canada Research Station, Lethbridge, Alberta T1J 4B1 Canada)

During an outbreak of the army cutworm, Euxoa auxiliaris (Grt.), [Lepidoptera: Noctuidae], the overall incidence of parasitism by the polyembryonic parasitoid, Copidosoma bakeri (Howard), [Hymenoptera: Encyrtidae], was 61% in pretreatment samples from 7 fields. The incidence of parasitism in samples collected on 5 dates from a single location, increased from about 20% in the early samples to about 50% in the later samples. Cutworms parasitized by C. bakeri feed longer than unparasitized ones, therefore, estimates of the incidence of parasitism based on samples of late instar cutworms are usually misleadingly high. The parasitized cutworms also grow considerably larger and many have an extra instar. Because cutworms parasitized by C. bakeri feed more and longer than unparasitized cutworms, a high rate of parasitism can increase crop damage and complicate control recommendations.

#112

STUDIES ON THE SPECIES AND POPULATION DYNAMICS OF ALATE APHIDS WITH A PRELIMINARY ANALYSIS OF THEIR IMPORTANCE AS VECTORS OF CMV IN TOBACCO FIELD. Li Juelu, Du Jinping, Qin Huanju, Wang Lihe (Tobacco Research Institute, Chinese Academy of Agricultural Sciences, Qingzhou, Shandong Province, 262500, China)

During studies in 1987-1990, alate aphids were monitored with yellow water pan traps in tobacco field in Shandong province. A total of 22918 aphids belonging to 50 species were caught. The number of species trapped was respectively 32 species in 1987, 37 species in 1988, 41 species in 1989 and 32 species in 1990. Dominant species in each of the four years were almost the same. The most abundant three species, *Myzus persicae* (Sulzer), *Lipaphis erysimi* (Kaltenbach) and *Aphis gossypii* Glover, comprised 53% of the total number of aphids collected during four years. Large population period was relatively regular in each year. Immigration of alate aphids into tobacco seedbed was first recorded as early as in April 7. It was in March that the number of aphids, as well as the species, was the most abundant. The number of species trapped in March accounted for 86% of the total species caught and the individuals comprised 69% of the total number. Population dynamics of the three dominant species were analysed and compared with the data of the incidence of CMV in tobacco. The importance of alate aphids as CMV vectors of tobacco plants was also discussed.

#113

STUDIES ON THE REPRODUCTIVE CAPACITY OF BROWN PLANTHOPPER NILAPARVATA LUGENS (STAL). Bingchao Huang, Bingyu Chen, Fulai Hong (Plant Protection Research Institute, Guangdong Academy of Agricultural Sciences, Wushan, GUANGZHOU 510640, China)

Brown planthopper Nilaparvata lugens (Stal) is the most important insect pest of rice in Asia and Pacific Region. It outbreak in Zhongshan county of Guangdong Province in the Pearl River Delta in the early stage of 1950's. Since 1970's, it has been the serious pest of rice in Guangdong Province of China. From 1989-1991 Year, the population dynamic and occurrence prediction models were studied. In this paper, the reproductive capacity and biological character and stage of different generations of brown planthopper in Guangzhou region were studied in detail, and compared with the reproductive capacity of white back planthopper Sogatella furcifera (Horvath). A large number of biological data of brown planthopper for prediction and control were reported.

#114

INVESTIGATION ON THE FLUCTUATIONS OF DORMINANT NATURAL ENEMY POPULATIONS IN DIFFERENT COTTON HABITATS AND INTEGRATED APPLICATION WITH BIOLOGICAL AGENTS TO CONTROL COTTON PESTS. Qinglei Wu (The Plant Protection Station of Zhucheng City, Shandong 262200, China)

From 1976 to 1990, a series of cotton field investigations in Zhucheng cotton-cultivated region confirmed that the population of dorminant natural enemies were markedly increased with improving the diversity of cotton agroecosystems as compared with monoculture cotton in a large area after interplanting host crops and oil- Brassica in cotton field. Beneficial parasitoids and predators were abundantly attracted in these stripes, as they moved into the adjacent cotton, two key pests, Aphis gossypii Glovor and first generation of cotton boltworm. Heliothis armigera Hubner were effectively controlled. By supplementary applications with selective insecticides to regulate the ratio of ladybird to aphis mass releasing egg parasite Trichogramma; spraying microbiocide 7216, and a nuclear polyhedrosis (NPV), the cotton bollworm was successively suppressed. According to the ecological aspests of integrated pest management, increasing the diversity of the cotton agroecosystem may improve the habitats of natural enemies. This program was practical in large scale control of cotton pests and acquired higher economic and ecological efficiency.

#115

A STUDY ON SEED CHALCIDS INJURING CHINESE MEDICINE HUANGQI(ASTRAGALUS SPP.). Ying Fan, Chun-qing Yang(Institute of Medicinal Plant Development, Chinese Academy of Medical Sciences, Beijing 100094,China)

The seed chalcids of Huangqi are serious pests injuring Chinese medicinal plant Huangqi(Astragalus spp.). The results of the study showed that it is a complex population including genus Bruchophagus(5 species)(Eurytomidae) and genus Habrocytus(1 species)(Pteromalidae). They are all new species. This paper deals with their classification, main bionomics, integrated control measures and main morphological characteristics of 5 species in Bruchophagus. They have similar habits, but differ in life-cycles, generations, and host plants. The most effective method for control has been proved by using the integrated control measures including cleaning fields, choosing healthy seeds and spraying 1,500X Dimathoat(40% E.C.) during flowering and green fruit stages.

INTEGRATED CONTROL OF WHITEFLY, TRIALEURODES VAPORARIORUM, BY ENCARSIA FORMOSA AND SELECTIVE PESTICIDES. De-lu Qiao, Guo-ren Zhu, Zheng-li Ju, Jiang-Zhou Zhao, Bao-yun Xu(Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, Beijing 100081,China)

The wasp-cards used in present study were supplied by mass propagation of Encarsia formosa. The selective pesticides, Buprofezin, Chinomethionat and Pirimicarb, were screened in lab and proved to be safe to the wasp. According to the fact of high density of the initial population of greenhouse whitefly in Chinese greenhouses, the authors set up an integrated control program based on planting non-infested plants, releasing Encarsia formosa, and applying selective pesticides. Results showed that this program was successful in getting obvious economic and ecological benefits.

A SURVEY ON THE VEGETABLE PESTS IN BEIJING. Jinrui Wang, Jun Wang (Institute of Plant and Environmental Protection, Beijing Academy of Agricultural and Forestry Sciences, Beijing 100081, China)

Systematic investigations were conducted between 1983-1985 on the vegetable pests in Beijing Area. Recorded pests belong to 2 Phylums, 3 Classes, 10 Orders, 44 Families and 116 species, of which 3 were new to China and 17 new to Beijing. Descriptions were made for each of the 30 main pests which caused serious damages of newly occurred or developed in recent years. Besides, the authors compiled the Beijing Vegetable Pests Catalogue and the Pests Catalogue according to Beijing Vegetable Families. In the Catalogues, the authors described the occurrence characteristics of the pests on the vegetable farms of four different ecological types in Beijing, analysed the causes of outbreak of certain pests and their growing damages as compaired with the previous decade, and suggestions were given for preventing and controlling vegetable pests in Beijing.

DEVELOPMENT AND IMPLEMENTATION OF RICE IPM STRATEGIES. Yu-chuan Li (General Station of Plant Protection, Ministry of Agriculture, Bejing 100026, China)

Rice is one of the most important crops in China, its sowing area reaches 22.8% of the total. Infestations caused by various insect pests are important limiting factors in rice production. A package of rice IPM strategies had been set through a research and practice over several years. It was implemented over 10 million ha in 1991. The application of pesticides and the amounts used were reduced by 50% and 46. 8% , respectively. Yield losses restrained was 4.8 million tons in the 4. 58 million ha of the IPM regions. Meanwhile, the cost of pest control was decreased by 12. 5%, and the net profit was increased by 17% for farmers trained with IPM knowledge in the regions. In addition, diversity of parasitic and predacious insects as well as the population of spiders were all increased apparently in the IPM rice fields. As a result, remarkable economic, ecological and sociological benefits were achieved.

METHOD FOR ESTIMATING THE EFFICIENCY OF PESTICIDE APPLIED IN ORCHARD. Tongzhao Duan (Chinese Agricultural Import and Export Company, Beijing 100810, China)

In the experiments of applying pesticides to control mites and aphids, the new method was used to estimate the efficiency of pesticides, which was based on the different grades of pest densities. The method is simple and makes survey process shorter. Three steps are as follows: 1. Determing the grades of pest densities, none is zero, and 1-5, 6-10, 11-20, 21-50, and) 50 insects on a leaf are I, II, III, IV and V grade respectively; 2. Calculating pest indexes by the following formula:

$$T\ (CK) = \{ \sum_{i=0}^{M} (i \times Ni) \ / \ [(\sum_{i=0}^{M} Ni) \times M] \} \times 100$$

T or CK: pest indexes in treatments or check; i: grade; N: the number of leaves at i grade; M: the top grade. 3. Estimating the efficiency of pesticides by the following formula: $P = \{[1-(Tn \times CKo)] / (To \times CKn)\} \times 100\%$ P: the efficiency of pesticides; To, Tn: the pest indexes before and after spraying pesticides respectively; CKo, CKn: pest indexes in checks; n: days or hrs after treatments.

THE MIGRATION AND FORCASTING OF THE PYRALID MOTH. Guichun Ma, (General Station of Plant Protection, Ministry of Agruculture, Beijing 100026, China)

The well known forage pyralid moth is the important insect pest of agricultural crop in North China. Once it breakout, it is violent, covers a wide area, its density is high and causes a great damage. Now it is evident that there is an outbreak base which lies approximately on 38-43 latitude and 108-118 longitude or on high sea level (1000-1600 elevation).

According to many years census: It reveals (1) The great difference of population density exists between two adjacent generatons. (2) According to the forcasting reports of 1980-1984, every year from June to September there were 4-6 times of sudden outbreaks which occupy an area of 3-7 longitude. (3) From sea voyage observation there are mass of moths passing the Northern part of Yellow Sea. (4)The dissection of moth ovary from over-wintering area shows that 1-2 grade of ovariole development occupies the leading note while in the non-overwintering area the 3-4 grade of ovariole development occupies the leading note, this shows that in the local area the emerged moths are migrated from other places.

Investigation of moth development through 1979-1982 there were two possible migrational routes. In both cases, the favorite forevailing air current were existed.

THE EFFECT OF USING PEPPERMINT OIL TO REPEL OVIPOSITION BY IMPORTED CABBAGE WORM (*PIERIS RAPAE*) Ju-wen Wu, Su-qin Wang and Bao-de Wang (Institute of Plant & Environmental Protection, Beijing Academy of Agricultural & Forestry Sciences, Beijing 100081, China)

Send-forth utensils of peppermint oil were set up in the cabbage fields of the suburbs of Beijing and Guangzhou, respectively. Foamed plastics fixed on top of bamboo poles at the height of the cabbage plants were used as absorber of the oil. In Beijing, a complete elimination of egg deposition by *P. rapae* was achieved in an area of 3 m. radius from the utensil by adding 15ml of the oil daily to each utensil. In Guangzhou, 10ml of the oil was added to each utensil every other day. The average number of *P. rapae* eggs found per cabbage plant (seedlings stage) was 0.17, 0.65, 0.90 and 1.68 at 0.3 m, 1.5 m, 2.8 m and 3.5 m distance from the utensil, respectively, indicating an increase of the egg deposition by 3.8, 5.3 and 9.9 folds, respectively, as the distance from the utensil increased. Direct application of a 90% emulsion of the peppermint oil on cabbage foliage caused severe phytotoxity. The phtotoxic effect could be avoided by diluting the oil preparation 1,000 times, but with greatly reduced repellent effect.

A STUDY OF EFFECT OF DIFFERENT CABBAGE VARIETY ON POPULATION DYNAMICS OF PERIS RAPAE L. Su-qin Wang, Ju-wen Wu (Inst. of Plant and Environment Protection, Beijing Acad. of Agricultural and Forestry Scie., P. O. Box: 2449-19, Beijing 100081, China)

An investigation was made on the ability of 19 cabbage varieties to trap P. rapae in May 1987. It was found that P. rapae had very strong selectivities to cabbage varieties. 19 cabbage varieties were cultivated in 1 Chinese mu, and each variety covered 15-20 cabbage, cabbages were checked every three days. The 19 varieties were divided into earlier-maturing variety, later-maturing variety and middle-later-maturing. The cabbage are with green and violet colours separately. The leavies showed creasy and uncreasy types. 32400 data analysing indicated that P. rapae showed preferenee to lay eggs on the later-maturing cabbages with creasy leavies and knitting loosely of early spring. Ca.5800 P. rapae can be found per 100 plants on the later-maturing cabbages. But it was difficult for P. rapae to lay eggs on those very early riped cabbages because of the wax layer on cabbage leavies. And the average of P. rapae per 100 plants was just 193. In addition, it turns out that P. rapae did not like to lay eggs on violet cabbages also bacause of the wax layer on the leavies. In a word, the damage of P. rapae to cabbages depended on the overwintering amount of P. rapae, climite of early spring, and the more important one was the cabbage varieties. If the early-maturing variety cabbages were planted in early spring, the damage of P. rapae would be avoided.

A FORTY YEAR REVIEW ON THE CONTROL OF WHEAT INSECTS IN BEIJING SUBURBS. Ren-jie Wu, (Beijing Plant Protection Station, Beijing 100011, China)

There are 180 thousand hectares of winter wheat planted in the suburbs of Beijing. The average yield is ca. 5385 kg per ha in 1991, which is ten times as much as that in 1949. The control of insect pests and plant diseases has played an important role in the output raised and nowadays the efficacy and lever of control are much higher than 40 years ago. In 1950s to 1970s, the soil insects, such as the mole cricket, white grubs and wireworms, were controlled by soil treatment with benzene hexachloride. In the latter part of this period, i.e. from 1960s to 1970s, seed dressing with parathion, phorate and phoxim was also adopted. Nowadays, the soil insects are no longer a serious problem. In 1950s to 1960s, the green bugs endangered wheat seriously. In addition, the grain aphic turned out to be a principal pest of wheat since mid-1970s. In 1980s, loss assessment and control index of this insect were studied and the relation between the grade of aphid population and the rate of yield reduction were difined. Since 1985, studies on the appearence and rule of migration of grain aphid were carried out and the regional distribution and migratory districts have been located clearly. Also, method of forecasting and measures for precautionary control were defined. Based on the results obtained, integrating control measures, including the protection of natural enemies and spraying of DDVP or omethoate, were developed and used successfully. In the recent decade, about 70 thousand ha of ground spraying and 100 thousand ha of aero-spraying were carried out annually.

THE EXPERIMENTS ON THE EFFECTIVENESS OF CONTROLLING TRIALEURODES VAPORARIORUM (WESTWOOD) ON TOMATO BY USING PUSHILING (BUPROFEZIN). Jun Wang, Zhili Zhang, Honghong Zhang, Hui Liang (The Institute of Plant and Environmental protection, Beijing Academy of Agricultural and Forestry Sciences, Beijing 100081, China)

Satisfactory effectiveness was achieved by using 10% Pushiling EC(1000x) to control greenhouse whitefly (T. vaporariorum). There were three treatments: spraying Pushiling one, two and three times respectively. The results showed that insect pests in every treatment were below the economic injury level and the average yield of tomato increased 29. 4% . And also, economic and ecological benifits were remarkable. The results indicated that Pushiling is an ideal insecticide for greenhouse whitefly control. This paper provided reliable basis for use of Pushiling in controlling greenhouse whitefly.

IMPROVING TECHNIQUES FOR FORECASTING AND CONTROLLING OXYA CHINENSIS(THUMB). Meiting Song, Wangquan Gao (Institute of Agricultural Sciences, Haidian, Beijing 100080, China)

O. chinensis has a generation a year. Eggs are overwintering under 1-2 cm earth at the edge of field or on long-narrow mounds of ditches, they hatch in the middle of May next year, larvae move to the paddy rice field damaging rice seedlings.

Some forecasting and controlling methods were formed. The forecasting was made by : 1. The conbination of surveying the density of eggs by digging the earth, capturing adults by insectnets and calculating the pest development, which was more accuratly than that only by net-capturing adults; 2. A proper control time was determined by an average egg-hatching rate. The spraying tools and control methods were changed, new chemicals taking place of old ones and all the rice field in the district being controlled at same time. The improved methods had been used for six years, accumulating control areas reached 34 thousand hu, reducing 18270 thousand kilo loss of rice.

ON THE OCCURRENCE AND CONTROL OF GRAPHOLITHA FENEBRANA TREITSCHEKE ON APRICOT IN YEN QING COUNTY, BEIJING. Jie Chang, Chong-lian Pu, Yu-zhu Wang (Institute of Forestry and Orchard, Beijing Academy of Agricultural and Forestry Sciences, Beijing 100093, China)

G. fenebrana is a serious pest on apricot in Yen Qing County where it causes approximately 80% fruit loss. It produces 2 generations a year on apricot tree, and spends about 40 days for a generation(7 days for egg stage, 23 for larva and 7 for pupa). There appear two adult peaks at the end of April and early June, respectively. The first generation larvae injure the apricot fruit before the stones become hardened and make fruit falling. The second generation larvae bore the fruits around the hardened stones. Pyrethroids were found to be effective for controlling the young larvae before boring into the fruits. Two applications would be necessary for the apricots for fresh using and one application would be enough for those used for kernel.

STUDIES ON INTEGRATED CONTROL OF TRIALEURODES VAPORARIORUM (WESTWOOD). Meizhen Xie, Meiting Song (Institute of Agriculture Sciences, Haidian, Beijing 100080, China)

T. vaporariorum is one of the most important pests on vegetables and flowers. The integrated measures to control this pest were studied: 1. Foster non-pest seedling before sowing, all of grass and dead plants under plastic top should be got ride of, then 0.25-0.35kg DDVP per plastic top, added a hand of sawdust, was used to fumigate the protected area; 2. All the plastic tops should be cleaned up and treated with chemicals when seedlings were transplanted; 3. During plants were growing, investigating was regularly made, whenever the pest was found, it should be control by releasing lacewings and Encarsia fomosa, and using DDVP to fumigate of spraying Buprofezin; 4. Yellow-boards were used to attract and kill adults; 5. Before plastic sheet was uncovered, Buprofezin, Bifenthrin and Fenpropathrin should be spraied to kill adults and nymphs so that the number of emigration decreased.

STUDIES ON ULTRA LOW VOLUME SPRAYING BY PLANES IN SHUNYI COUNTY, BEIJING SUBURBS. Dianchen Wang. (Plant Protection Station, Shunyi 101300, China)

Since 1983, ultra low volume spraying by planes has been used to control aphids in wheat field. 18 "yun 5" planes especially for agriculture have flown 852 times, worked 994 hours, sprayed 240 tons of mixed chemical DDVP and Omethoate. Controlled areas reached 240 thousand ha, which was 80% of total wheat fields that should be controlled. After the treatment 48 hrs, the average control efficiency achieved 93.6%. Pirimicarb, mixed chemicals which was DDVP and Omethoate (1:1), Fenvalerate were screened in May 1984 and 1985, the results showed the first two chemicals were good, but the efficiency of Pirimicarb was not stable. So mixed chemicals was selected as ULV formulations, it had the advantages of low cost and strong systemic effect. Using above technique could be labour-saving and get good social and economic benefits.

THE PRACTICAL PROBLEMS ON CONTROL OF INJURIOUS ACARID. Dian-jing Zhang (Tianjin State Farm Bureau, Tianjin Plant Protection Society, China)

(a) The formation of resistance in acarid is the process of natural evolution of biological populations. Reason for this is mainly due to the interference to their occurence, and fluctuations (improper use of chemical means) made by human being in their production, just as Darwin said that it was the result of aftificial selection in natrue. This result shows that species is hard to abolish, thus, the formation of resistence enables the injurious acarid to reproduce and exist and it a also made work for those who involve in plant protection and pesticides. (b) The formation and increase of the resistance of injurious acarid is an unavoidable phenomenon in pest control. In other words, we can say that it is a challenge of the injurious acarid to human being, yet, it can be postponed through proper management. (c) Chemical product is still an important means in prevention and control of injurious acarid at present. Therefore, whether a good acaricide can be selected in numbers is of great importance. (d) Measures to diminish the resistance of acarid must also be taken through spreading plant protection knowledge among farmers in the way of universal education and training.

OCCURRENCE AND CONTROL OF STRIPED FLEA BEETLE(PHYLLOTRETA VITTATA FABR.). Hui-zhong Zheng, Shi-chang Wu, Zhong-liang Shen(Plant Protection Research Institute, Shanghai Academy of Agricultural Sciences, Shanghai 201106,China)

Striped flea beetle is becoming serious in Shanghai in recent years on cruciferous vegetables. Population dynamics in fields showed that the beetle occurred from May to August, with its peak in middle or late June to middle or late July, and it caused yield loss after middle August. It was proved also by yellow pan.traps. Spraying 50% Phoxim E.C. and 48% Chlorpyrifos E.C. gave 100% mortality five days after application, and gave 71.9% and 88.6% mortality, respectively, seven days after application. By checking rates of broken leaves the controlling effectiveness of 90% Trichlorphon was 60%, 5% Phoxim G. was 56.4%, and 25% Shachongshuang solution was 61.8% five days after applications.

ANALYSIS OF INTEGRATED MANAGEMENT OF FRUIT INSECT PESTS IN CHANGLI COUNTY DURING THE PAST THIRTY YEARS. Zi-gang Cao(Institute of Pomology, Hebei Academy Agriculturcl and Forestery Sciencc, Changli 066600, China.)

Practiccs throughout the past 30 years showed that rcactions of insect pests to human controlling mcthods varied significantly. According to their reactions, insect pests could be divided into four ecotypes. Ecotypc I is composed of 13 species of pests such as Illiberis pruni, which can bc controlled completely. Insects of this group havc somc characters in common: feeding less than pests in other groups, and dcstroying fruit crops in a visible way. Continuous controls over several years could depress pest population so much that it was very hard to find any pests in the orchards afterwards. Ecotype II includes Grapholitha molesta and other thrce species. Thcir feeding spcctrum is limited and they migrate a little. Insect population in a large area has been decreascd to 1% for several years, and times of controlling could be reduced by 50–67%. However, controlling methods can not bc stopped at all. Ecotype III includes pests that can suddenly appeared in a enormous population. Only onc species has been found belonging to this typc by now, i. e. Leucoptcra scitella. Ecotype IV are mites on apples and hawthorns, which can breed and devclop resistanse to insecticides very quickly. So, we must deal with them time after time. In addition, populations of other 12 spccies were getting smaller during that pcriod, such as Rhodococcus sariuoni etc.

PRELIMINARY REPORT ON STUDY OF LAMPRA LIMBATA GEBLER. Qing-hai Huang, Wang-fang Chcn (Forestry Bureau of Botou City, Hebei 062150, China)

Lampra limbata Gebler is a dcstructivc trunk borer of pear. The pupa of this insect is primarily relatcd to temperaturc, which begin to occur in the third decade of April, most of the pupae occur in the second decade of May, and at thc beginning of June stop to occur. Mild, high humidity weather favour the emergence of adult, and rainfall is closely rclated to thc emergcnce of adult, Emcrgence of adult begin in thc sccond dccade of May, happen abundantly in third decade of May and stop in second dccade of June. The life span of male adult is shorter than female adult. Pears and dead locusts are both damaged by this pest. The pest population dcnsity on dcad locusts is 7.9 to 12.9 times than on pears. Spraying chemicals ovcr trccs ,scizing adults, fumigating larvae which borc insidc the trunk, brush chcmicals over the branches to kill thc larvae inside, intensive cultivation to improvc the trec hcalth, can be used to control the pest effectivclly.

STUDY ON THE TIME-SPECIFIC LIFE TABLE AND ACTION THRESHOLD OF COTTON APHIDS(APHIS GOSSYPII GLOVER) IN THE SEEDLING STAGE. Chun-sheng Miao, Yu-ying Sun, Hua-qi Zuao(Cangzhou Agricultural Research Institute, Changzhou, 061001, China), Shang-wen, Zhang, Gui-rong Wei(Changzhou Agricultural Technical School, Changzhou, 061000, China)

The technique systcm includs three parts: 1. the time-specific life tablc of cotton aphids in the secdling stage and its using system. It's two life table. By using $ex > 1$ determine key period of control, 1–3 timcs of insecticide application could be reduced. 2. The dynamic model of the yield loss based on aphid injury. Including two lincar regression equations in which X = percentage of curly leaved plant, Y = percentage of yield loss in 1–3 and 4–8 true leaves stages: $y(1-3) = -0.3890+0.3886X$; $Y(4-8) = 9.5662+0.2307X$. EIL(1–3) = 4.13%; EIL(4–8) = 15.9%. 3. Thc action thrcshold system. The relationship between pencentage of curly leaved plant (Y) and the aphids population per 100 plant (X) can bc cxpressed as: $Y(1-3) = 4.2384+0.0351X$; $Y(4-8) = 18.6326+0.0069X$. Based on EIL, thc action threshold of cotton aphids in 1–3 and 4–8 true leavcs stage in the low or middle output field of cotton were 11.67% and 27.46% of curly leaved plants or represented as 212 and 1460 aphids per 100 plants respectively.

STUDIES ON NATURAL POPULATION LIFE TABLE OF THE COTTON BOLLWORM (HELIOTHIS ARMIGERA HUBNER), IN CENTRAL AND SOUTH HEPEI. Luan-chen Liu, Hai-ying Cui, Zhi-ming Li (Dry Farming Institute, Hebei Academy of Agriclture and Forestry Scince, Hengshui 053000, China)

In 1978–1987, 22 life tables and three generations mean life tables were established after fixed time tracing observations on natural population of generation of the cotton bollworm(CBM). The results showed that for first to thired generation, the indices of population trend averaged 11.999, 4.926 and 20.407; the generational survival rates averaged 4.15, 2.55 and 9.05; the survival curves of all three generations of the CBM natural population were of Price A type. The natural population of cotton bollworm has a increase tendence. The number-affected key stage were first instar for first generation, third instar for second generation and fourth instar for third generation. All the key factors appeared density independence. Natural enemy was also an important restrictive factor and affected environmently to some extent. The analizing of the relationship between generations showed that the number of first generation CBM in the winter wheat fields was positively correlated to the number of second generation CBM in the cotton fields with a determing coefficient of 0.51. Negative correlations were presented for the generational survival rates between adjacent generations but significantly negative correlations between 2nd and 3rd generations ($r = 0.8919$, $p < 0.01$).

A STUDY ON BIOLIGICAL CHARACTERISTICS OF MILLET SHOOT-FLY (ATHERIGONA BISETA KARL). Yao-jin Gan, Han-zhang Zhou (Institute of Millet Crops, Hebei Academy of Agricultural and Forestry Sciences, Shijiazhuang 050031, China); Li-qi Gao(Chengde Institute of Agriculture Sciences, Chengde 067000, China)

Millet shootfly is an important pest in millet growing area in north part of China. It has 2 generations in spring millet area with the average yearly temperature of 9℃, and 3 generations in summer millet area with average yearly temperature of 13.2℃. The adults have clear attendance to the odour of putrid fish and have choice when they lay eggs. The incubation of eggs and feed of larvas need high humidity. The time of old larvae leave plants to overwinter depends on the variation of temperature. The larvae overwinter in the soil of 10 cm under ground. For both spring millet and summer millet, the damage of later sowing is heavier than earlier sowing. Intercropping will be damaged heavier than single cropping and densive fields damaged heavier than thinner ones. The relative humidity from middle July to carly August is signifficantly related to the damage of millet shootfly in 2-generation area. 3 natural enemies of millet shootfly have been discovered. Among them, Halticoptera atherigona is a new species.

A STUDY ON PEST-RESISTANCE OF MILLET TO MILLET SHOORTFLY IN DIFFERENT DEVELOPING STAGE AND ITS USAGE. Han-zhang Zhou, Yao-jin Gan(Institute of Millet Crops, Hebei Academy of Agriculture and Forestuy Scicnces, Shijiazhuang 050031, China)

From 1988–1990, through natural damage and artificial inoculation, the study of pest-resistance of millet to millet shootfly in differcnt developing stage was carried out by using millet varieties with different pest-resistance. It has been revealed that: (1). The dead-heart rate of millet is negatively and significantly related to leaf age($r = -0.96$ * *). The pest-resistance of millet to millet shootfly in different developing stage has significant differences. (2). Seedling stage is a sensitive stage. After jointing stage, the millet begin to have pest-resistance. The pest-resistance increases as the leaf age increases in spike formation stage. After heading, millet is free from damage. (3). According to the different pest-resistance of millet to millet shootfly in different developing stage and the regulation of millet shootfly, the sowing time of millet can be regulated to reduce damage. The test of 3 years show that early sowing is a simple, easy to-do, economic, and effective measure for cultural control.

THE FECUNDITY, INTRINSIC RATE OF INCREASE AND FUNCTIONAL RESPONSE OF APHIDIUS GIFUENSIS ASHMEAD (HYMENOPTERA, APHIDIIDAE). Zheng-duan Ji, Zhang-bao Bi(Department of Plant Protection, Hebei Agricultural University, Baoding 071001, China)

The fecundity, reproductive rates and adult survival of Aphidius gifuensis Ashmead parasitizing second and third instar numphs of peach green aphids, Myzus persicae(Sulzer) were measured under constant laboratory conditions. At host densities of 5,10,25,50,100, or 200 aphids / day the parasite lived average of 5–6 days at 22℃. Both the number of egg laid and the aphids parasitized the mean total numbers per female parasite increased with host density and were limited by the numbers of host available at the host density less than 50 aphids / day. analysis of the data showed that the intrinsic rate of natural increase varied with the host density. It reached maximum value at density 200, calculated as 0.3641 female / female / day. The host density showed no significant effect on the mean generation time, but the net reproductive rate increased to 18 times as the density increased from 5 to 200. The parasite's functional response was a typical type II response preposed Holling and decelerated with increasing density. The intrinsic attack rate (a′) and handling time (Th) were estimated from functional response curve as $a = 6.9881$ days^{-1} and $Th = 0.01668$ day. The number of aphids attacked at each density was predicated satisfacterily by random parasite equation.

NEW FORMULATIONS OF SYNTHETIC PHEROMONE AND MATING DISRUPTION FOR CONTROLLING FIRST AND SECOND GENERATION ADULTS OF THE ASIAN CORN BORER, OSTRINIA FURNACALIS(GUENEE). Wen-de Li, Su-xin Chen, Shu-fa Zhang(zhangjiakou Technical College of Agriculture, Hebei, 075131, China), BI-xian Li, Li Zheng, Yong Liu, Shu-lan Gao, Guang-yi Zhang(Dry Farming Institute, Hebei Academy of Agriculture and Forestry Science, Hengshui, Hebei, 053000, China), Zhi-hong Wei, Guo-xin Yu, Jun-xiang Yu(Jiangsu Institute of Pheromone, Jintan, Jiangsu, China)

New formulations, the sticky paste and the polyethylene film, of synthetic pheromone of the Asian Corn Borer(ACB), Ostrinia furnacalis(Guenee), were developed, which were proved to be of many advantages over the formers such as more convenience of applying, less cost, higher ratio of pheromone utilization and desirable effect of mating disruption. During 1986 to 1990, 25 active reacion trials and 11 mating disruption trials were conducted in the fields in different areas in Hebei, and the results showed no significant difference of the male-attracting activity and the mating disruption ability of both forms comparing with the check, former successful formulation. During 1988 to 1990, a total area of 24000 ha was treated by applying both forms of synthetic pheromone in the mating sites in Noth Hebei for controlling 1st generation ACB adults, and the results showed significant effect with more than 80% less stalks tunnelled and less cavities / 100 plants.

ARGUMENTS ON THE PRINCIPAL ECONOMIC RESISTANCE PROBLEMS OF THE COTTON APHIDS (Aphis gossypii Glover) PART II CHALLENGE AND COUNTERMEASURE. Ben-jun Cao, Bing-zong Zheng (Beijing Agricultural University) Kai-lian Fu, Gao Hong, Guo-dong Yong, Bing-heng Zhang (Hebei Agricultural University, Baoding 071001, China)

Through several years' studies on the important theoretical-practical sequential cross resistance problems of cotton aphids, we basically ascertain that the following sorts of OP-CARBAMATE insecticide groups relatively exhibit lower resistance levels against cotton aphids, they are still able to control them with high-effectiveness under econmic application rates (0.3–0.45Kg ai per hectra). We believe that these insecticide series can be applied in proper rotation to delay resistance progress with appropriate acception of cost effectiveness. (1) Organophosphorus Groups: Monocrotophos Omethoate Malaoxon Oxydemetol-methyl Chlorpyrifos N-deisopropyl isofenphos- methyl etc. (2) Carbamate Groups: Methomyl Furadan Propoxur etc. (3) Certain OP-OP synergistic mixtures: Quinalphos Fenthion Malaoxon Cyolane-methyl series etc. (4) Certain OP-CARBAMATE synergistic mixtures:

The effective resistance countermeasure strategy-programs is suggested by us and is prmcipally based on that:(1) in case of the AchE mutants the resistance pattern of the alleles is different. High resistance to one OP compound in one of the strains sometimes corresponds with a low one in the other strain, whereas the reverse can be found for another compound. (2) Through proper rotation with different kinds of the OP-CARBAMATE groups possessing low resistance degyecs. we still can eradicate the RS hybrids of high-resistant strains to a comparatively great extent thereby arrive at restain of possible intensifation of the established dominant altered AchE resistance mechanism and sequential criss-cross resistance to a certain degree.

A STUDY ON CONTROLLING COTTON SEEDLING APHID BY CHEMICAL-LURKING METHOD. Li-ming Bao (Department of Science, Cangzhou District, Hebei 061001, China)

One of important integrated measurments to cotton pests was to use method of chemical-lurking to control aphid in Huang-huai cotton regions, which included two ways: 1. Using No. 1 agent (containing 24% carbofuran) to coat cotton seeds, which efficient period was 35-50 days: 2. Smearing the stem and leave by rope smearing technique (it was better to use 8% synergist omethoate and 5% monocrotophos), its effect died away after 10 dasy, this way was followed the first one, otherwise two or three times should be used. The advantage of this method was labour-saving, especially in the summer harvest period: reducing spraying times and environmental contamination: efficently protecting the natural enemies among which ladybirds increased as two times, lacewinge three times, small flower bugs three times and Aphidiinae seventeen times in the reducing-spraying areas as those in normal controlled areas, in the meantime the method was useful for control cotton bollworms.

STUDIES ON THE SPECIES AND CONTROL METHOD OF GARDEN FLOWER APHIDES AND SCALES IN TAIYUAN. Hui-di Zhang (Institute of Garden Science,Taiyuan,Shanxi Province 030012,China)

Aphides and Scales are main pests of garden flowers,We have made an investigation for three years on 300 kinds of garden plants in Taiyuan,and found 71 kinds of aphides,63 kinds of scales and27 kinds of natural enemies.Among them there are two new species of scales and two new species of aphides which have never been found in China.They are Chorizococcus laiyuanensis n.sp.,Physokenmes shanxinensis n.sp.,and Macrosiphum mordvilkoi Miyazaki, Brachycorynella asparagi (Movdvilki).

In addition,studies on the control method show that Carbofuran and Aldicarb are effective against the pests when the granules are put into the soil of flowerpot.The advantages of this method are easy to use,no air pollution and retain effect for a long time.In a field it is effective to spray Omethoate or Fenvalerate against aphides before the leaf rolling or the cecidium forming,and against scales soon after the most of their eegs hatched.

EXPERIMENTS AND RESEARCHES ON THE BIOLOGICAL CHARACTERISTICS AND INSECTICIDE PREVENTION OF Thrips simplex. Duan Bansuo (Baotou Horticulture & Tree Gardening Research Institute, Baotou, Inner Mongolia 014010, China)

Thrips simplex is one of main insect pest on Gladiolus hybridus. All Gladiolus in Baotou infected with the pest. An investigation from 1988 to 1990 shows that the pests occurs 7-8 generations each year and has a serious over-lapping generations. They start active stage in a temperature over 5°, and the imagines can overwinter inside the bractcal leaves of bulbdium in middle of October. There are came differences for each period of generation in various areas and reasons in Baotou. Female instars generally live 15-35 days. Threshold of growth and total effective temperature are 10.8°C and 53.2 day-degree for eggs, 8.1°C and 84.1 day-degree for the age of 1-2, 8.4°C and 74.9 day-degree for the age of 3-4, 5.14°C and 305.35 day-degree for eggs to the prophase of ovipositions. The sex ratio in is 1:0.8-1:0.25 and with parthenogenesis. I simplex begins to oviposite 1 or 2 days after mating. The oviposition period lasts up to 28 days and the proper temperature for the oviposition is 15-250C, The pests may also live on other plants. Temperatures, humidities and illumination may affect their activities. In chemical control experiment, 1500X 40% ome-thoate and 30X machine-oil decis plant surface application, or 15% aldicarb and "Zeolite-Insecticide" crown application showed best effects in which more than 95% pests was killed.

THE CONTROL OF THE LONGICORN IN SEABUCKTHORN ORCHARD. Ren-jun Fan, Jin-min Dong(Plant Protection Institute,Shanxi Agric. Academy, Taiyuan 030031, China),Man Cao,Ying Liu (Seabuckthorn Institute,Youyu,Shanxi)

Common seabuckthorn(Hippophae rhamnoides)is widely distributed in China with a total area of 680,000 hectares, of which Shanxi province accounts for 340, 000 hectares. For many years, longicorn(Asias halodendri)which is main pest of the tree has severely damaged the orchard, thus we have studied its control for 4 years. Results showed that the combination of all agricultural measures which enhance the resistance of the plant and spraying or injecting insecticides is effective. In the peak of the imago stage, spraying 80% DDV or 40% Omethoate (1000X) is effective. The best method is" injection method" in the larva stage. Procedures of the method are: first on the trunk 10-30cm above the ground surface drill 2-4 holes,the gradient of the hole is 45 degree, then inject systemic insecticides such as 40% Omethoat, 50% parathion with injector into the holes.The effectiveness is above 95%. In addition, it can control aphides, Psylla and Halyomorpha concurrently.

STUDIES ON ECONOMIC THRESHOLD AND LOSSES CAUSED BY THE CABBAGE CATERPILLAR AT THE CABBAGE SEEDLING STAGE. Yan-hua Liang, Yu-liang Jia (Station of Plant Protection and Qurantine of Linfen prefection, Linfen 041000, Shanxi Province, China)

The cabbage caterpillar Pieris rapae Linnaeus is a dominant pest in the cabbage fields. Its damage losses is serious for the young cabbage plants. Experiments on its damage losses relations showed that losses in cabbage yield are closely correlated to the number of caterpillars per plant. The regression equation is :Y=40170. 41-0.06x. It is considered that economic injury level of the cabbage caterpillar should be kept between 0.8 percent and 1.2 percent. Before the third instar larvae is the critical moment for the spraying insectcides of Bacillus thuringiensis. This should be done when the number of cabbage caterpillars are found below 33 caterpillars per hundred of young cabbage plants.

A STUDY ON PTERYGOTIUM VARIATION OF CHAITOPHORUS POPULIALBAE (BOYER DE FONSCOLOMBE). Youlian Li, Tao Su (Depat.of Plant Protection, Shanxi Agric. Univ., Taigu 030801, Shanxi, China)

Chaitophorus populialbae, one of the principal pests on abele (Populus alba L.)and Populus tomentosa Carn, is popular in Shanxi province.A careful study has been conducted on the pests since 1983.The resultant obsevation discovers the popularity and continuity of the pterygotium variation. This paper is aimed at describing the processes of pterygotium mergence, displacement and disappearance of C. populialbae. It is considered that the tendency of decrease in the number of pterygotium is one of the biological characteristics of C. populialbae, and greatly alters with the change of temperature.

STUDY AND APPLICATION ON TECHNIQUE OF INTEGRATED CONTROL INSECT PESTS IN WHEAT FIELD IN CERTAIN AREA SHANXI PROVINCE. Wang-yi Zheng, Hui-xuan Qu, Rui-cai Xie, dong-sheng wang, Qing-yun Yin Dong-zhi Ren (Institute of Wheat Research, Shanxi Academy of Agricultural Sciences, Linfen 041000, Shanxi, China), Yan-gou Zhang, Yu-liang Jia and Xian-tao Ji (Plant Protection Station of Linfen Prefecture, Linfen 041000, Shanxi, China).

According to systematic thought and eclolgical system of wheat field, it is considered that the integrative relationship between wheat, insect pests and natural enemies. On base of above, net of food, structure, niche, succesion, distribution and law of major population of insect community have been studied in wheat field in Shanxi from 1984 to 1990. And technique system of integrated pest management adapted to given region has been established. " Jin 31" and "Jin 32" that are fine wheat varieties of high resistance to Sitodiplosis mosellana (Gehin) and "Jin 36" and " Linyuan 207" that are fine varieties of resistance to aphides have been chosen, demonstrated and popularized. The technique has been demonstrated and popularized in over million um wheat field in eighteen counties in four prefectures of Lin-fen, ect. in Shanxi. The obvious effects in society, economy and ecology have been obtained.

STUDIES ON THE BIONOMICS AND CONTROL OF MELOLONTHA FRATER ARROW. Gui-ming Guo, Guang-rui Lui, Jian-en Hou (Institute of Plant Protection, Shanxi Academy of Agricultural Sciences, Taiyuan 030031, China), Ming Yang, Huan Jia (Yanggao County Science and Technology Committee, Yanggao 038100, China)

Melolontha frater Arrow (Coleoptera, Melolonthidae) is one of the main underground pests in Shanxi. It is indicated that one generation of the insect is carried out for four years. The first, second or third instar larvae began to move to deeper soil layer during 10th to 20th October. They overwintered in the soil at 180 cm depth. The pest started to active in April. From 20th May to 10th June all the insects moved to the cultivate layer at 20 cm depth & began to damage the crops. The duration of larvae lasted about 46 monthes. Then, the old third instar larvae made rooms & pupated in the soil at 18 to 39.5 cm depth. The pupal period was about 40 days. From 20th June to 10th July, they emerged to adults & began to mated & oviposited in the evening, but did'nt take food.

Investigations showed that application with 10% Mocop granules at the rate of 0.5 to 0.75 kg per mu mixed with 15 to 20 kg of soil by covering it on the potato tuber when sowing or with 25% tiny capsule of Phoxin or Parathion at the rate of 0.1 to 0.2 kg per mu by seed dressing can give satisfactory results.

THE BIOLOGICAL CHARACTERISTICS OF THE SMALL RICE GRASSHOPPER AND ITS CONTROL, Ai-ping Zhang, Xing-he Feng and Guo-quan Di (The Plant Protection Station of Xinzhou Prefecture , Shanxi Province, China)

The small rice grasshopper Oxya chinensis is a important pest occuring in Xinzhou area, Shanxi, China. During early year, the pest lives in some bank with grasses, and then migrates into rice fields. Other crops are also attacked by this pest, such as maize, beans , sorghum, cattail and reed. This pest reproduces one generation each year and overwinter as egg, usually along the irrigation cannals or the low banks in field and under the soil surface 1-2cm, at where the soil is loose and fertile. The overwinter stage covers 255 days , The nymph stage is 50-70 days and adult stage extends 47-101 days. The main life habits are aggregation, migration and omnivorous. When the pest population is more than 40/m² in field, rice grain can be lost 16.9-22.0%. Fungi, predatory insects, birds and frogs are its nartural enemies. Control measures include: 1. destroy its overwinter habitations by reclimng and ploughing the low field bank; 2. catch the pest by nets during July and august; 3. protect the natural enemies; 4. spary pesticides in protective bands outmargis of the rice fields in mid June to obstruct the grasshopper migrationg into or spreading over the field.

STUDIES ON THE BIONOMICS AND CONTROLLING METHODS OF SCYTHROPUS YASUMATSUI KONO ET MORIMOTO. Lizheng Li, lianchang Li, Yongliang Fan, Guanglu Shi, Meijun Zhao, Jie Li (Institute of Entomology, Shanxi Agricultural University, Shanxi 030801, China)

Scythropus yasumatsui Kono et Morimoto is an important jujube pest. It has one generation a year and larva overwinters in the soil. It feeds on the tender leaves and buds of jujube trees. On the average, one female oviposits 52.5 eggs. The longevity of female is 38.5 days and male is 32.8 days. The egg stage is 11.4 days. The hatching rate of eggs is about 91. 6%. Eggs are laid on branches. More than 90% of the larvae overwinter in the depth of 0-13 cm of the soil and 92. 3% of the overwintered larvae pupate in the depth of 0-3 cm of the soil. Natural mortality of pupa is 11.7% The result of insecticides test shows that, 2.5% PP321, 2.5% Decis, 40% Fenvalerate and so on are very effective. The method of shaking the tree trunk is most effective comparison with other methods. This method is based on the habit which the pests falls off to the ground when disturbed. In the period of adults in full, shaking the tree trunk with a wood hammer while spraying the insecticide (1.5% E605 powder) on the ground under the tree canopy, in case of the beetles escape. The controlling effect is 96.98%. Comparison with the usual method of sparying insecticides on the tree canopy, it saves man-power and insecticides, effective and economical.

STUDIES ON THE DISTRIBUTION AND CONTROL METHODS OF BORERS IN SHANXI PROVINCE. Yi Yan, Rui Wang (Institute of Plant Protection, Shanxi Academy of Agricultural Sciences, Taiyuan 030031, China,), Zhi Shi, Ji-qing Li , Yuo-guang Li (Shanxi Plant Protection Station, Taiyuan 030001, China)

The distribution, generation , damage and control of two borers (Ostrinia furnacalis and Chilotraea infuscatella) were studied by means of insect sex pheromone, violet light and other methods in different ecological regions. The results showed that there were five ecological regions in Shanxi province. First , no occurrence region in frigid mountain area with an elevation of 1500 metres , frost-free period is less than 100 days . Second , one generation region in lower 1400metres above sea level, frost-free period 100 days or so. Third, one to two and two generation region, thirty-six to thirty-nine degree north latitude, frost-free period 150 days . Fourth, thirty-six degrees north latitude beyond south is two to three generation region. Fifth, three generation region is thirthy-five degrees north latitude beyond south.

Chilotraea infuscatella damages seriously in the mountains region. with an elevation of 1300 meters , whereas Ostrinia furnacalis in plain. The chemical, agricultural and biological control were utilized in different region and a good-results were obtained.

STUDIES ON THE NATURAL POPULATION LIFE TABLE OF RHOPALOSIPHUM PADI(LINNAEUS). Su-juan Li, Jing-luen Wang , Zhi-min Wang, Yu-qing Wu (Institute of Plant Protection, Henan Academy of Agricultural Sciences, Zhengzhou 450002, China)

A natural population age-specific life table of six generations was constructed for R. padi, overcomming the disturbance of the generation overlapping and the migratory flight of the alatae by seperating generations in 1988-1989. Studies on the table shows that key factors influencing the natural population fluctuating were weather and natural enemies. Wind and raining were chief factors influencing the young nymph which can be reduced by more than 22.6-50.0% in density in a strong wind and heavy raining. While natural enemies as well as wind and raining were main factors influencing the old nymph and adults. Of natural enamies, ladybird (esp. Coccinella septempunctata Linnaeus) ,hover flies and spiders (esp. Misumenops tricuspidatus (Fabricius)) were important. R. padi is a typical r-strategists. It has high matality as well as high intransic rate of increase , which indicates that the fluctuating of R. padi population is also influenced by its own density.

A PRELIMINARY STUDY ON THE RESISTANCE OF WHEAT VARIETIES TO WHEAT APHIDS. Jing-lun Wang, Su-juan Li, Xing-yun Wang, Yu-ting Zhang, Jian-wi Sun (Institute of Plant Protection, Henan Academy of Agricultural Sciences, Zhengzhou 450002, China)

Four species of wheat aphids commonly infest wheat in Henan: the English grain aphid(Macrosiphum avenae(Faricius)), the bird cherry-oat aphid(Rhopalosiphum padi), the green bug(Schizaphis graminum), the rose grain aphid(Acyrthosiphon dirhodum). In front of two wheat aphids were the most serious insects.

The resistance of 314 wheat varieties to wheat aphids were determined in the field in 1987-1990. With preminary-screening and muti-screening, 7 varieties apears highly level of resistance to wheat aphids, 2 varietes were better on agronomic character and yield. The resistance factors to wheat aphids were preminary studied too. Result showed that there were close relation between the resistance and number and length of hairs in wheat leaves. Hairs of varieties of highly level of resistance were 8.1-9.1 times as much as susceptible varieties, but them were 22.2-44.5 times as long as susceptible varieties.

THE EFFECT OF SOIL TEMPERATURE AND MOISTURE UPON *ATRIJUGLANS HETAOHEI* YANG AND ITS CONTROL COUNTER-MEASURES. Yi-zhi Sun, Wen-jun Zhang, Bi Luo, Zhi-yong Be (Plant Protection Depart., Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

In this study, it is firstly determined that the starting temperatures for pupation and eclosion of overwintering lavae of *Atrijuglans hetaohei* Yang are 9.4℃ and 10.4℃ respcetively, and the effective accumulating temperatures are 276.3 day degree and 196.3 day degree. Soil temperature is the key factor affecting the generations of *Atrijuglans hetaohei* Yang, and the water content in soil is the main factor affecting pupation and eclosion of the larvae. Meanwhile, the ecological conditions of the outbreak of the pest are also demonstrated. It is suggested that changing ecological conditions of the overwinter cocoons be the essential strategy for controlling the infestation of the pest.

STUDIES ON THE YIELD LOSSES OF WHEAT BY BROWN WHEAT MITES, PETROBIA LATENS(MULLER) (ACARINA : TETRANYCHIDAE) AND ITS ECONOMIC THRESHOLDS. Guei-zhong Han, Sheng-liang Wang, Jiu-si Gao, Shun-tong Liu (Agricultural Research Institute, Luoyang 471000,China)

The studies on the wheat losses of yield damaged by Petrobia latens (Muller) and its economic thresholds were conducted in 1990-1991 at Luoyang, Henan Province, China. Results showed that the economic injury level of wheat yield by the mites was 2.5 %, and the economic thresholds were 1400, 6700 mites per 100 stems or indexes of injury 1 %, 6.5 % at reviving and stem elongation stages respectively.

A STUDY OF *SCELODONTA LEWISII* BALY. Yi-zhi Sun, jian Qi, La-ming Zhang (The Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

Scelodonta lewisii Baly is widely dispersed in the southeastern part of Asia. The present paper for the first time reports the biological characteristics of this pest and its integrated control measures. In Danfeng County of Shaanxi Province there is only one generation in a year and overwinters with the adults in the soil. After finishing their hibernation, they begin to eat youg leaves, tender sprouts, inflorescences and fruit stalks and cause abscission of blossom and fruits. In the middle of May, the adults begin to lay eggs, and then the overwintered adults die in succession. In the last ten days of May the larvae are incubated, and a month later, this year's adults begin their eclosion and continue damaging grape plants till leaf dropping in autumn. In this paper the authors suggest that ploughing deeply the soil under the crown of grape trees and watering them in winter, spraying organophosphous pesticides at the stages of new bud formation and young fruit emergence be the effective measures for controlling the damage of the pests.

THE INFLUENCE OF TEMPERATURE ON THE EXPERIMENTAL POPULATION OF TETRANYCHUS VIENNENSIS ZACHER. Yajun Zhou, Shiping Han (Department of Plant Protection, Henan Agricultural University, Zhengzhou 450002, China.)

The influence of different temperatures on the ecological characteristics of T. viennensis was studied in laboratory by rearing on detachet apple leaves in Apri.-Oct.,1990.It was found:The modified form of the biophysical model of Sharpe and DeMichele provides an excellent description of development rates of T. viennensis at a series of different constant temperature. Simulations show that the optimum temperature for the development of the mite is 35-37℃,and the upper threshold temperature is 39-41° C. The developmental zero and total effective temperature for development from egg to adult of the mite are about 12.6℃ and 190.7day degrees respectively.The relationship between the life-span of the female adults(Y),average fecundity per female(S) and temperature(T) are as follow: $Y=39.1376-0.8683T$, $S=-97.6637+11.1799T-0.2061T^2$ respetively. The matrix model of the experimental population of the T. viennensis was caculated and analysed under different temperatures. Analysis on the relationship between innate capacity for increase (r_m), net reproductive rate (R_o) and temperature (T) leads to the following equations:$r_m=0.2889/(1+\exp(3.8347-0.15817))$, $R_o=-54.4342+6.1343T-0.1074T^2$

PRELIMINARY STUDIES ON THE BIOLOGICAL CHARACTERS OF *CARPOSINA NIPONENSIS* WALSINGHAM LIVED ON THE DIFFERENT HOSTS. Lei Hua (Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

There are some differences in the biological characters of the peach fruit moth, *Carposina niponensis* Walsingham, lived on the jujubes, the wild jujubes and the apples. The beginning time and the peak time that wintered larvae come up out of the ground as well as the adult emergence time in the field, which live on the jujubes and the wild jujubes, delayed 8 days, 20 days and 20 days respectively than ones of which live on the apples in the suitable temperature and humidity. The pre-pupate and pupate stage of the former are shorter than that of the latter also. The initial temperatures and the accumulated temperatures of this stage lived on the jujubes are 1.43℃ higher and 26.52 day-degrees less than those of which lived on the apples in the constant temperature laboratory.

The eggs of the peach fruit moth are deposited at the back of the leave base on the jujubes or at the hollow of the fruit base on the wild jujubes. There is 1 generation a year. The periods of the larvae were 40-50 days. which are about 2 times of that lived on the apples. Studying results show that the peach fruit moth is of different "host bio-types".

STUDY ON SPECIES, BIONOMICS AND INTEGRATED CONTROL OF CRICKETS IN PEPPER FIELDS. Guang-jun Wu, Zhi-jie Chen, Sou-lian Zhang, Mei-rong Zhang, Yao-jun Wu (Shaanxi Institute of Zoology, Xian 710032, China)

There are six species of crickets in pepper fields. *Gryllus testacells* Waller is the main species in irregated area of pepper fields in Guanzhong Region. *Loxoblemmus doenitzi* Stein is the common species of different ecological districts in Guanzhong, Shaannan, Shaanbei Regions. All the crickets are one generation per year and overwinter with their eggs about 1.5–2.8cm inside of soil in southern exposure around canals, ditchs, tombs and mountain ridges. The hatch period of eggs is the last ten days of April, the nymphs take place from the last ten days of April to the first ten days of september, the adults appear mainly from the last ten days of August to the last ten days of September. The key period of damage is from August to September. Both phototaxis and chemotaxis are obvious. Intretilling weeds, ploughing deeply, irrigating water, transplanting peanuts, protecting spiders and other enemies, using pesticide and so on are effective measures in the cricket managament.

RESEARCH ON CONTROL COPHOPROPRA SP., THE MAJOR PEST OF CINNAMAMUMU CASSIA PRESL. Jianfeng Liu, Zhicheng Liu, Chungxia Wang, Wuhong Yang (Plant Protection Research Institute, Guangdong Academy of Agricultural Sciences, Guangzhou, China)

Cophopropre sp. (tip moth) is a seriou insect pest occured in Cinaamamumu cassia Presl. A rager rate of dead shoot damaged by tip moth is 43%, Max70%. In pass 3 years, the biology of tip moth was studied. It is over six generations per year. The peak of occurence is in June, July and August. Integrated control of tip moth have been developed. From spring to autumn, periodic release Trichogtamma sp. 10000/mu to against tip moth in the peak of egg stage. The results show that the parasitism rose 60.49%-92.60% and dead shoot declined 54. 10%-96% respectively. In the peak of larva of tip moth, chemical control may be used as the supplementary step. After surveying the yield in the field, the controlled area retrieve loss 70% and increase income 87.4 Yuan/mu.

A SYNTHETICAL EVALUATION ON THE OPTIMUM CONTROL PERIOD AND THE INSECTICIDE EFFECTS UPON CONTROLLING WHEAT MIDGE. Yao-dong Dong, Yang-sheng Chang, De-fang Zhang, Fang-qin Xie (Yangling Station of Plant Protection and Quarantine, Yangling, Shaanxi 712100, China)

The optimum control period and insecticide effects upon controlling wheat midge, *Sitodiplosis mosellana* (Gehin) were studied in 1986–1990. The results showed that the best controlling period to wheat midge, major controlling period, was the time when the pupae were in their fully growing period. The next controlling period, supplementary controlling period, was the peak period of adults. The insecticide effects upon wheat midge, economic benefits and the relation with the yield of wheat could be used as the objective function to carry out decision-making analysis, the results indicated that the controlling effects of insecticide in the period of pupae were 87.91%, 86.4% and the number of imago at the ear of wheat reduced 93.95%, 91.23%, with the 40% Isofenpmfos-methyl and the poisonous soil made with 2.5% 1605 powder respectively. In the period of adult, the optimization effects of insecticide, the controlling effect, was 84.85% with the 2.5% 1605 powder. The sensitive of the adult to insecticides was the largest.

THE STUDY OF THE BERRY BUG, *DOLYCORIS BACCARUM* L., IN JIANGSU. Geng Jiguo, Zhang Jianxin, Zhang Jialin (Department of Plant Protection, Nanjing Agricultural University, Nanjing, 210014, China), Wang Guangzhi, Wang Changya, Xu Xuekun (Tobacco Society of Jiangsu Province)

Dolycoris baccarum (Linnaeus) (Hemiptera: Pentatomidae) is a worldwide insect pest, which measures about 8.0–12.5mm long with 5.5–6.5mm wide. The insect has great range of hosts in the world. It has become an important pest of tobacco in Jiangsu, Henan, Shandong, Jiangxi, Zhejiang and Helongjiang provinces recently. Systematical studies on the bionomics were carried out in Nanjing, Jiangpu and Longtan during 1987–1990. The insect has 4 generations each year in middle-low area along Yangtze River and South Jiangsu, while it has 3 generations in North Jiangsu. It overwinters in adult stage. Population dynamics are affected by temperature, humidity and crop rotation. The second and third generations damage the spring and summer tobacco greatly.

STUDIES ON CONTROL OF INSECT PESTS BY SPREADING A SLOW-RELEASING PESTICIDE ON COTTON, RAPE AND OTHER CROPS. Ming-li Dong (Weicheng District Station of Plant Protection, Xianyang, Shaanxi 712100, China)

Good results were achieved in the respect of pests control of cotton, rape and so on by applying a slow-releasing pesticide, advantages of which were decreasing pesticide pollution and no doing harm to natural enemy. The spreading method of a slow-releasing pesticides could coordinated chemical control and bio-control. Beneficial results of economy, society and ecology were proved by applying the method to control cotton pests in the field of Yellow River valley.

STUDIES ON BIONOMICS OF ALLANTUS BUCTIFER (SMITH). Wei-zhuo Feng (Jiangsu Burea of Agricultural Reclamation, China)

Allantus butifer (Smith) is an important leaf-eating pest on buckwheat. It has 5 generations per year in Jiangsu Province China, and overwinters in pupae or old larvae in surficial earth cells. The eggs are laid in the leaf spongy parenchymatous tissue near the midrib. Each female can lay 70 eggs, the duration of egg stage is 5-7 days. Early instar larvae accumulatively damage the leaves, the fourth and fifth instar larvae attack buckweat, larva period lasts 8.9-21.8 days. The developmental threshold temperature of larvae is 15.2 1.2°C, effecive thermal sum is 81.3 13.9 day-degrees (r=0.8599). The development threshold temperature of pupae is 19.5 4.1oC, effective thermal sum is 56.6 0.28 day-degrees (r=0.9877). High density pests and serious damage occur on buckwheat growing in low-lying and shady lands. The mortality of prepupae in lower-temperatured and dry winter, and in the year with great April rainfall are high. The natural enemies include a kind of parasitic fly and a kind of virus. Therefore, agricultural control should emphasize the eradication of out-field hosts such as Polygonum lapathifolium and P. aviculare, and irrigation during pupation. Chemical control should pay attention to the selection of organophosphorous and pyrethroid chemicals which have good contact and stomach toxicities.

DYNAMICS OF AGROTIS YPSILON POPULATION IN NORTH JIANGSU. Chuan-jin Zhou (Huang Hai Farm, Jiangsu Province, China)

The characteristics of the first stage of population dynamics of Agrotis ypsilion (Rothemberg) in North Costal Reclamation Area of Jiangsu Province were great number of adults and small ratio of larvae to adults (female) in cotton and corn fields. In the second stage, the amounts of adults deeply decreased, but the ratio of larvae to adults was bigger than that of the first stage, and in cotton fields it was bigger than that in corn fields. The ratio of larvae to adults in cotton fields was smaller than that in the second stage, and in corn fields it was much higher than that in cotton fields. There were some factors affecting the population dynamics:

1. The ratio of larvae to adults in cotton and corn fields was sychronized with the temperature increase in late April and early May.
2. Mechanical soil preparation coincied with egg peaks. thus the activity eliminated a lot of eggs and postponed the damage peak of larvae.
3. Extensive use of triflurin in cotton fields increased the process of soil mixture and decreased the eggs.
4. Cultivated land and the change of weed kinds were favourable to larva survival.

FURTHUR STUDY ON THE EGG-LAYING OF THE COTTON PINK BOLLWORM IN THE FIELD. Cheng-yu Feng (Haian County Station of Plant Protection and Quarantine, Jiangsu 226600, China)

Field obseravations on the egg-laying of the cotton pink bollwormn (Pectinophora gossypiella Saunders) at the cotton boll stage in 1988 have proved that in the cotton field there were over 3.16 green bolls on a plant, the females of the second and third generations largely laid their eggs on the green bolls on the middle and lower fruit branches of the cotton plant, and less on the upper ones; eggs of the second generation of this insect were laid about 58.56% on the cotton bolls of the second and third conic layer from outer to inner, and 73.20% on the third and fourth layer during the third generation. Females of the insect mostly selected the green bolls which are over 10 days old to lay their eggs, and the number rates of egg on the bolls of 20-34 days old reached 55.02%. The females usually laid their eggs into the lumps including 1-13 grains of the egg, and the mean numbers of each one were about 2.9184 2.0119 grains. On each green boll. there were approximately 3.2923 2.5764 grains of the egg.

BIOLOGICAL CONTROL OF COTTON PESTS IN COTTON-WHEAT INTERPLANTED FIELDS. Pei-long Chen, Kun Wang, Hai-nan Liu (Institute of Agricultural Science of Sheyang County, Jiangsu Province, China).

The ways of cotton pest biological control were studied in cotton-wheat interplanted fields in Sheyang County, North Jiangsu Province from 1984 to 1988. The results showed that Aphis gossypii was a very important and sensitive factor in ecological system in cotton fields. On the one hand, A. gossypii harmed the cotton seedlings, causing damage to the plants and yields. On the other hand, it was the food resources of many natural enemies in cotton fields. Chemical insecticides were not used for the control of A. gossypii before the end of June, thus the total number of major predators increased by 47.96%, the pests decreased by 58.62%, the number of stem eaten by asian corn borer decreased obviously. The damage had been decreased. The differences of major agronomic characteristics of cotton were not obvious. The yield and quality of cotton had not been affected too. The ecological and social benefits were very good.

THE CHANGING CROPPING SYSTEM AND CONTROL TACTIC OF CARMINE SPIDER MITE. Xiao-wu Zhao (Qidong Plant Protection Station, Jiangsu Province, China)

Carmine spider mite (Tetranychus cinnabarinus) is a main harmful mite on cereal and cotton plants. The damage of carmine spider mite varies with crops. Control tactics of the carmine spider mite are removing bridge and cutting way in maize and cotton intercropped fields, contolling selectively and early in pure cotton fields, and using natural enemy mainly with subsidiary of chemical control in pure cereal fields.

STUDIES ON THE DAMAGE AND CONTROL OF WHEAT WIREWORM IN WHEAT FIELDS. Li-ming Wu (Xinyi Plant Protection Station, Jiangsu Province, CHINA)

Wheat wireworm mainly damages the base of wheat stems, causing dead seedlings and the decrease of spike numbers before stem pushing, and white ears. the decreases of grains of per ear and thousand kernal weight after stem pushing. Pot incubation tests for continuous 4 years and field systematic investigations show that the wireworm doesn't attack the wheat seedlings untill the early Spring next year. It reaches the infestation peak at early shooting period. The main characteristics of the infestation are:

1. The populations of the wireworm are mainly distributed in dry farm lands along the river banks and in the sandy soils of hilly mounds.
2. When the average 10-day temperature reaches 3°C, the wheat wireworm begins its infestation, when the average temperature stabilizes at 9-12°C, the damage peak occurs.
3. Dry weather and less than 10% water contains under 10 cm soil surface can depress the infestation, while well-distributed rains for many days and 12-18% water contains under 10 cm soil surface will make infestation break out.

When tillers turn green, the wireworm can be controlled effectively by ethion or phoxim.

ON LOSS ASSESSMENTS IN SOYBEAN BY GRUBS AND THRESHOLD FOR CONTROL. Zheng-Yu Li (Plant Protection Station, Guanyun County, Jiangsu Province, China)

The greatest effect caused by grubs on the yield of soybean is the number of full-grain per plant, which ($\hat{Y}n$) and densities of insect (heads/m) (X_1). The plot yield ($\hat{Y}y$) and X_1 as $\hat{Y}y=401.153-11.992X_1$. The loss of plot ($\hat{Y}_l$) and the index of root damage (X_d) can be presented as an exponential equation, $\hat{Y}_l=0.2295e^{6.173897X_d}$. Basing on the assessments of loss can be suggested as 4-5 heads/m^2 at the begining of hatching of grubs. The relationship between the index of root damage and density of grubs is useful to check the number of surviving insect at the post stage of soybean.

STUDY ON CONTROL STRATEGY TO MELANAGROMYZA SOJAE. Jian Wang, Zhengyu Li (Plant Protection Station of Guanyun County, Jiangsu Province, China).

The numerical relationship between fecundity, survival rate of Melanagromyza sojae Zehntner and developing stage of soybean was studied. Together with the research results of yield loss rate, we propose that the economic injury level (EIL) for the pest is 0.23 larva per plant and the economic threshold (ET) is as follow:

Branching period (first generation of M. sojae):
225 adults per hectare;
Blooming period (second generation):
1500 adults per hectare;
Podding period (third generation):
2250 adults per hectare.

Ovary development of M. sojae can be divided into 5 stages. Control effect to 3~5 day adults, whose ovaries reach stage VI and oviposition peak, is the best. So, the time for most effective control is 4 days after imago peak. Adults favour soybean in early flowering stage. When imago peak synchronizes with early flowering period, damage is more serious. If the generation of M. sojae is overlaping and its imago peak lasts long, we can anatomize adult ovary systematically to determine oviposition peak. Then the time of pesticide application can be scheduled according to growth period of soybean.

The research also gives out parameters used in short-term prediction of population dynamic and density of M. sojae.

CONTROL LEVEL OF SOYBEAN APHIDS(Aphis glycines M) ON SOYBEAN IN NORTHEASTERN OF CHINA. Fan Jun & Zhonglin, Dai (Plant prot. Dept., Shenyang Agr. Uni., Shenyang, . 110161, China.)

The effect of Soybean aphids on soybean yield was studid by artificial infesation of aphids in soybean with different densities and controlling at different growth stages of soybean in the field in 1988 and 1989. A dynamic figure threshold, which used graduation of soybean developmental stage as the absicissa, logarithmic value of the aphids numbers as the ordinate, was given out. With this figure threshold, whether the aphids in the field needs to be controlled would be known directlly.

A STUDY ON THE BIOLOGY AND CONTROL OF THE PILLBUG, Armadillidium vulgaris (Latreilla) (Isopoda, Armadillidiidae). Yu-wen Jiang, Lan Jia, Zhen-chang He (Shenyang Agricultural University, Shenyang Liaoning Province, 110161, China), De-ming Meng, Chang-ying Sun (Agricultural Technology Extended Station of Red Flag Town, Dalian 116022, China).

The pillbug is a pest which is taking place recently in Dalian, China. It damages seedlings of cucumber, tomato. rape seriously. It has one generation in two years and overwinters in adult or larva stage at a depth of 30-50 cm under the ground. It endangers seriously from April to May. Eggs are laid in a marsupium from late April to early May and hatch from the marsapium in late 20 days of May. Hatched larvae are released about 2 to 3 days. Adult and larva are active at night because they are afraid to light. It plays possum, and gets into ball form when it is disturbed. The effective control measure is soil treatment with 2.5% deltamethrin and 20% fenvalerate (0.4-0.8ml/m), 50%dichorvos and 25% phoxin (2-4ml/m).

ECOLOGICAL EFFECTS OF INTEGRATED PEST MANAGEMENT IN APPLE ORCHARDS. Lian-deng Dou, Yu-shu Zhou, Ci-ren Zhang (Research Institute of Pomology, CAAS, Xingcheng. Liaoning 121600, China)

This paper was based on the research data from 1987. The effects of pest control and ecological effectivity on the apple orchards of Integrated Pest Management (IPM) and General control (GC) were analysed. Population of leaf feeding insects, mites, aphids were controlled always under economic threshold value. Based on standpoint of community ecology, the character changes of insect community in orchards after applying different control measures were analysed, in order to evaluate advance and feasibility of IPM technique. It played an important role in raising applied levels of IPM technique and promoting development of IPM theory.

STUDIES ON THE LIFE TABLE OF ASIAN CORN BORER (Ostrinia furnacalis Guenee).. Xin Lu (Department of plant protection shenyang agricultural university, shen yang 110161, China)

The life table of Asian corn borer(Ostrinia furnacalis) are researched by the author from 1989 to 1991. Analysed the effect of environment factor and biological factor to Asian corn borer. The trend index of population (I) of the first generation Asian corn borer are obtained in Shenyang area Liaoning Province. It is clear that the key stage is 1—3 instar. The main mortality factors are the life resistance of corn to young larva. The transference death of newly hatched larva and some parasite natural enemies. The death-rate is lower during 4-5 instar, the mortality factors are, Beauveria bassiana, bacterium, Nematode, Macrocentrus and Lydolla grisescens. The main mortality factor in pupa stage is phaeogenesiguchii; Trichogramma ostrinia is the main mortality factor of second generation Asian corn borer in egg stage.

DISCUSSION ABOUT CONTROLLING OF OSTRINIA FURNACALIS GUENEE. Jiqiu Zhao (Institute of Plant Protection, Liaoning Academy of Agric. Sci. Shenyang 110161, China)

Ostrinia furnacalis is one of the most important insects which damage the corn and sorghum, and cause a great deal loss every year. Till now, there is no efficient controlling method, especially to the second generation. There are many reasons to cause the second generation. The writer thinks that the follow work should be done; studying the O. furnacalis in an all-round way; enforcing study of plant resistance and resistance occurrence; noticing the second generation; controlling O. furnacalis from the aspect of ecology; cooperation the work of eliminating pest; working harder for pest forecast.

STUDIES ON THE POPULATION DYNAMICS OF CUCUMBER APHIDS AND THE SAMPLING TECHNIQUE. Ceng-jun Sun, Qi Chao, ji-qiu Chao, Guo-qing Xu, Shou-ping Lu (Plant Protection Institute of Liaoning Provincial Academy of Agricultural Sciences, Shenyang, 110161 China) Guang-xue Zhang (Animals Institute of China Academy, Beijing 100080 China).

The result showed that large amounts of aphids on spring cucumber under natural conditions last from the end stage of June to the early stage of July. Plants with rolled leaves and amounts of aphids on single plant shows as close as following, $y=77.67x-360.90$, $r=0.9572$, $p<0.01$. Based on Iwao theory, vertical distribute pattern of cucumber Aphids is a concentrated distribution Sequential sampling was applied. Aphids amounts on the three leave (the 4th, 5th, 6th leaf from root upward) relate to aphids amounts on the whole plant, $y=0.5026 = 0.9855x$, $r=0.9756$, $p<0.01$, the result above could be used to guide controlling, and saved a large amounts of investigation time.

STUDIES ON OCCURRING PRINCIPLE AND CONTROL MEASURE FOR EURYTOMUS SP. Fuzhi zhao (Plant Protection Station of Nanpiao District, Jinxi city, Liaoning Province 112500, China), Shuang Zhang (Plant Protection Station of jinzhou Liaoning Province)

An experiment was carried out to show the occurring principle and control measures for Eurytomus sp. (Eurytomidae, Hymenoptera) which has occurred very seriously in the apricot orchards both in Jinzhou city and Jinxi city in recent years. Peak stage of adult emergence is suitable control perild, control measures are either spray of fumigant action. For spray, 800X of 50% 1605 was applied, intermitted seven days, spray two of three times. For fumigant action, 80% DDVP was applied, mixed with wooden powder, covered by plastic bag. The plastic bag was hung on the apricot tree, three bags for the matured tree. Both measures have significant control effect, approximeate 93-95 percentage.

THE PROTECTION METHOD AND THE REGULARITY OF OUTBREAK OF THE SOIL INSECTS OF GINSENG. Jun Li, Zheng-de Chao Fu-yu Sun De-ping Shong Su-jie Tong (Plant Protection Institute of Liaoning Academy of Agricultural sciences, Shenyang, 110161 China).

Ginseng is previously injured by soil insects, average injuring percentage is 30% or so, yield is descreased 20—25%. Two kinds of chief soil insects, grub is Holotrichia diomphalia Bates, wire worm is Selatosomus latus Fabricius. After winter, insects were investigated, there were 16—20 heads in one cubic meter soil, death percentage was 20% or so, townwards 20-80cm under soil surface. The active period of wire worm is relative to soil temperature, full injured period is in the first and middle ten days of June. Isofenphos-methyl is the best effective insecticide.

A STUDY ON MIDDLE AND LONGTERM FORECASTING MODEL FOR OCCURRENCE OF THE MAIN AGRICULTURAL INSECTS AND CONTROLLING TACTICS IN KAZUO COUNTY. Li-de Sun (Meteorological Bureau of Kazuo County, Liaoning, China 122300).

This study had been made for 10 years (1979—1989). It had been found that the relationship between the occurrence and development of the main agricultural insects and the environmental conditions in Kazuo county. The meteorological law which armyworm, cotton bollworm, sorghum aphids, locust develops was grasped. The correct probability of the middle and long-term forcasting model on microcomputer is 85.7%. The ration of input to output was 1:253, this ratio was obtained from 3-category assessment method. Based on the result mentioned above, the optimal decision making of insect control was accomplished. The Monte conlo method was applied to the quantitative assessments of the climatic occurrence probability of insect occurrence and other statistics values. This work gave a scientific basis to the study of insect occurrence regularities.

STUDIES ON THE BIOCHEMICAL BASIS OF RESISTANCE IN SORGHUM TO SORGHUM APHID MELANAPHIS SACCHARI. Fugang He (Institute of Plant Protection, Liaoning Academy of Agricultural Sciences, Shenyang 110161, China)

The biochemical basis of resistance in sorghum to sorghum sphid Melanaphis sacchari (Zehntner) was studied by chemical analysis of fifth and sixth leaves when the plants were in the earing stage. Four susceptible varieties and four resistance varieties were used. The results indicated that the leaves of the susceptible varieties and significantly higher levels of soluble nitrogen, sugar, and many free amino acids, especially the essential amino acids when compared with that of the resistance varieties. The sap PH of the resistant sorghum leaves displayed slightly acidic while it was neutral in the susceptible varieties. Multiple regression analysis showed that the resistance to the sorghum aphid is negatively correlated with the contents of soluble nitrogen, sugars and free amino acids the sorghum foliage.

THRIPS ON GLADIOLUS AND THEIR CONTROL. Xiuwan Jiang, Jiufang Gao (Shenyang Municipal Institute of Landscape-Gardening 110015, China)

This paper deals with the species, occurrence, damage and control methods of thrips on gladiolus in Shenyang area. Immersing with phenol and using granules of 3% Furadan with 3kg/mu in the soil can control gladioulus thrips effectively.

STUDIES ON INTERPLANTING OF CHINESE SORGHUM OR CORN WITH MILLET OR WHEAT FOR CONTROLLING THE ARMY WORM OF THE SECOND GENERATION. Ern-cun Wang (Liaoyang County, Liaoning Province 111000, China)

The armyworm is a kind of important inset pests on cereal crops including wheat, millet, Chinese sorghum and corn. It occures extensively and causes a great damage to the crops every year. We had made a number of experiments in plots, many places and popularizations over a large area for 4 years (1976-1979). The result shows that by applying of interplantiog every 100 rows of chinese sorghum or corn (also 100 rows) with 10 rows of millet or wheat (also 10 rows). In this way, the populations of insect are much concentrated so that they can be controlled more effectively. In addition, the basic number of the second generation armyworms on chinese sorghum of corn are usual below the index arm of control, and a new technique of chemical insecticides are needed to control the army worms only on millet or wheat instead of chinese surghum or corn.

ONE NEW SPECIES OF THE GENUS FANNIA FROM LIAONING CHINA (DIPTERA: EANNIIDAE). Lianfu Zhang (Hygienic and Anti-Epidemic Station of Chaoyang City, Liaoning 122000, China) Wanqi Xue (Department of Biology, Shenyang Normal College, 110036, China)

The present paper deals with a new species of Fannia of Fanniidae, Fannia nigriclara sp. now. (Figs. 1-2). Male: This new species resembles to Fannia clara Collin, 1937, but differs from the later in the mid-tibia with 2 bristles on the anteroventral surface; palpi very small. female: Unknown. Holotype, Lingyuan County (Dahebei, 40° 54'N, 188° 59' E) , Chaoyang City, Liaoning Province, May. 9. 1991. collected by Lian-fu Zhang.

A PRELIMINARY REPORT ON THE DATE OF CONTROLLING THE CORNBORER. Ji-zeng Chen (Liaoyang Agricultural Institute, Liaoning province 111000, China)

The cornborer is one of the most destructive insect to corn and the chinese sorghum in Liaoning area. It occurs nearly every year and causes serious damage to these crops.

It is as a general rule, that soon after controlling the army worm of the 2nd generation, the cornborer of its first generation must be controlled like wise. Because the time presses and the raining season will be coming sooner, the controlling measures are unavoidably delayed. In addition, these crops will be growing up taller and thicker. These undoubtedly bring us a lot of difficulties for spraying insecticides in the fields.

The tests of small plots, different locations and large area for controlling this insect from 1981-1984 have proved that the 0.5% ethyl parathion granular insecticide applied to eradicate it on June 20 or so, i. e the early middle days of central leares of corn, was very efficient to both the corn borer and army worm.

THE OCCURRENCE AND CONTROL OF CHILO SUPPRESSALIS WALKER. Jianfu Li (The Plant Protection Station of Dandong, Dandong 118000, China)

There are two generations in a year for Chilo suppressalis in Dandong City, and larvae overwinter in straw or in the remained root of rice plants in the field after harvest. The first generation causes leaf sheath withered and the dead heart. The second generation make plant produce white ear and also damage the leaf sheath. The control of Chilo suppressalis is applied the insecticides such as Anthou, Accothin and Pyrethrins. The killing rate of these insecticides are over 95%. The author discussed integrated control of this insect pest in present paper.

IPM ENSURE RICE TO BE INCREASED YIELD. Yushan Wang (Plant Protection Station of Panjin City, Liaoning 124010, China)

Paddy rice is planted in Liaohe river delta, about 100,000 hectares. Rice fales smut, rice sheath blight, rice foot rot, rice plant hopper, Asiatic rice borer, rice leaf roller, and rice grasshopper injure the rice. The output of rice was decreased 30-50 million kg by insect pests and diseases a year. Since 1985, IPM program has carried out in Panjin County. The yield of rice increased year by year. The author discussed the key techniques on IPM in rice field in present paper.

THE DAMAGE OF PANONGCHUS ULMI AND THE NEW CONTROLING METHOD. Desheng Yu, etc. (Plant Protection Station of Jinzhou District, Dalian 116100, China)

Through several years investigation, the writers have gained three conclusions: 1) The harmfulness of P. ulmi. The yield of damaged orchard decrease 44.3 percent and the first grade apples decrease 29.7 percent. It also affects the next year flowering and yield. 2) The effect of present chemical controlling methods to biotic community. There are more kinds number and diversity of natural enemy in uncontrolled orchard than in the chemical controlled orchard. The ritio of prey natural enemy and P. Ulmi is 1:90 in uncontrolled orchard. This is 20.4 times as many as that in chemical controlled orchard in which the ritio is 1:183.4 3)The new controlling method and its effectiveness. The new controlling method that restricts chemical pesticide applying frequency and protects and attracts natural enemy to control the P. Ulmi may stabilize the apple orchard biotic community, increases the diversity and natural enemy numbers, and thus decreases the controlling cost.

BIOLOGICAL PROPERTIES OF POLYPHYLLA LATICOLLIS LEWIS. Xiangyu Li (Agricultural Technology Station of Tabenzalan, Fuxin County, Liaoning 12000, China)

Polyphylla laticollis is one of the main insects injuring crops and trees in fuxin County. This lamellicorn beetle is dominant species in Fuxin region. Its biological properties are observed and studied in Fuxin county during 1976-1982. Also, the author discussed control methods in this paper.

STUDIES ON THE BIONOMICS OF DELIA FLORALIS (FALLEN). Sun Fuyu and He zhencang (Institute of Plant Protection, LiaoningAcademy of Agricultural Science, Shenyang 110161, China)

Studies were carried out in 1987—1988 in Liaoning Province. The turnip root fly has one generation a year, and it overwinters in the pupal stage. Adults emerged in late August to late september, the peak of emergence occured in early september. The average life-span of the adults was 20.9 day. The average period of development of eggs larvae and pupae were 5.8, 32.9 and about 315 days. The average period of preoviposition and oviposition of female were 6 and 18 days. The average number of eggs laid by every female was 48.5 days. The pupae of turnip root fly have the character of diapause under the higher temperature. The overwintered pupae are treated under the conditions of constant temperature 15 and 20℃, or under the conditions with variant temperature (first, the pupae were treated 40 days in 25℃, then placed in 15 or 20℃), the diapause of pupae could terminate the period of emergence 30—50 days early than the natural conditions

STUDIES ON THE BAIT TRAP OF ONION FLY. Xueqiang Teng, Zhenchang He (Dept. of Plant Protection, Shenyang Agric. Univ., Shenyang 110161, China).

The writer reports the trapping effect on onion flies by 3 different traps. The results showed that, of the 3 traps, one small-net-trap (SNT) caught 2869 and 381 onion flies within 81 days in 1985 and 15 dyas in 1991 respectively. This paper describes the structure of SNT and the methods of using it, and also introduces bait composition.

A STUDY ON APPLICATION OF THE HIGH-VOLTAGE ELECTRON PEST-KILLER TO CONTROL THE FOREST PESTS. Chun-sheng Zhang (Shenyang Metallurgy and Machinery College, Shenyang 110044, China), Hong-yang Pan (General Station of Forest Pests and Diseases Control of the Forestry Ministry, Shenyang 110031, China)

High-voltage electron pest-killer, is a high efficiency, automate-control equipment for controlling insect pests. It was designed base on the normal light trap with a bi-winged electrified wire net. It not only can be used to collect insect specimen, monitor the population dynamics of insects, but also can be used to control insect pests. The radius of attractalbe light source is about 1000m, and the main efficient peak is between 21-23 o'clock. It can be used in single, small group and crowded. It is best to use under the fair and no wind weather condition. The percentage of attracted famele moths counted 29.4-84.8%, and the percentage of eggs were 26.7-70.7% among the traped moths. Base on the experiment of using the pest-killer to control the forest pests in 60 thousands ha., this pest-killer had significant effect to many important forest pests, such as Dendrolimus tabulaeformis, D. spectabilis, D. superans, Lymantria dispar and Clanis bilineata. The reduce rate of the pest dynamics was 73.7-93.0%.

PRELIMINARY BIOLOGY RESEARCH OF HAWTHORN SLUG SAURFLY AND ITS CONTROL. Zhi-Xian kang, Shu-quin Yan, Bai-ren Yi, Yao-ge Huang, Ling-sheng Kang, Yan-zhong Shi (Jilin Agricultural University, Changchun 130118, China), Xiao-song Yu (Ptant Protection Station of Jilin Province, Changchun 130021, China), Rui-zhen Zhao (Forest Biocontrot Station of Jitin Province, Changchun 130051, China).

Hawthorn slug sawfty (Attatus sp.), a kind of monophagous pest wich only attacks hawthorn teaves, has been found in Chang chun area of Jitin province recently. Maybe it is a new recording species in China. This insect is one or two generations per year in Chang chun area. The second generation only partly happens with the phenomenon of generation overlapping. The larva of the last stage makes cocoon and passing winter in the soil where underground 0-7cm under the hawthorn trees, nearby the roots of weeds and under the fatten leaves. Starting pupation in early June and emergence in middle June. Adult lays its eggs into the leaf tissue. Eggs are laid by a dispersing way. Larva eats on the back of the leaves. The leaves eaten by larvae remain onty the upper epidermis and vein with some inordinate transporent spots and a few hotes. Aboul 80-100% of the leaves are injured when the insects occur heavily. Occurence of the larvae are mainly in Juty. Adults and larvae of the last stage have the character of feign death. The foltowing insecticides coutd be used in present prodution, 50% Phoxim Ec 50g a.i./100 titres (HV), 20% Fenitrothion Ec or 20% Fenpropathrin Ec 4-5g a.i./100 titres (HV)

MORPHOLOGY AND BIOLOGY RESEARCH OF GREENHOUSE WHITEFLY. Yao-ge Huang, De-wen Cui, Shu-qiu Yan (Jilin Agriculturat University, Changchun 130118, China), Ugo Cirio (TECAB, ENEA, C. R. E. Casaccia-S. P. Auguillarese, 301, Casella Postale N. 2400-00100 Roma A. D. Italy)

Among the reports of greenhouse whitefty Triateurodes vaporariorum Westwood, some call its youthful stage as "tarva", while others call it as "nymph", We have observed all of the growing stages and studied some biologicat charecteristic of greenhouse whitefty. According to our primary observation, the wing bud can not be found in each stage from the 1st. instar to the 1st. phase of the 4th. instar of the youth. We think that its metamorphosis is more near to complete metamorphsis. So that, the youthful stage of greenhouse whitefty is better called "larva" than "nymph". Under the temperature of 20℃, one generation, 33 days, and 25℃, 19 days with the condition of RH=70% and L : D=16 : 8 hours on the tomato cv Vesuvius. Plant growing stage affects the quantity of oviposition, 73.16±30.56 eggs on young plants and 20.4±9.7 eggs on old ptants. The average of mating duration is 4.68±1.37 minutes and the mating frequency is higher on the morning and evening than on the other time during a day. Greenhouse whitefly can disperse to least 180cm, but most of them onty disperse about 60cm. Its dispersal is affected by the tight in greenhouses.

A STUDY ON THE FIELD DISTRIBUTION OF LARVAE OF CACOPSYLLA SP. Li-fei Ling (Jilin Agricultural University, Changchun 130118, China), Xian song Wang (Plant Protection Station of Jilin, Changchun 130021, China)

This paper reports on the study of field distribution pattern of larvae of Cacopsylla sp. which is new hawthorn pest in Jilin province. The results of X^2 test, Taylor index test, IWAO regression test and the parameters of I, C, m^*/m, Ig indicated that the larvae were of negative binomial distribution of gathering type. Thus, a suitable sampling technique had been proposed.

BIOLOGY AND ECOLOGY OF ELDANA SACCHARINA WALKER. Ying Huang (Sugarcane Research Institute of Fujian Agricultural Academy, Zhangzhou, China)

E. saccharina was found occurring seriously in the lately reclaiming sugarcanc farms in Liberia, Zaire, Sierra Leone, Togo and Mali in Africa during 1977-1988. The borer occurred 6-7 generations a year. The duration of each generation was about 40-60 days. The egg was divided into four stages, the larva had 6-7 instars, and the pupa was divided into four stages in Sierra Leone. The rate of incubation of the eggs was usually 80%. The characteristics of the larva were wide recipes, high resistance to bad conditions and high infection rate. The adult had obvious taxis to dead sugarcane leaf. The female adult corld only mate one time in her life, but male 1-3 times.

It was unfavourable to the growth of latelyincubatde larva in long-term dry or rain season, but favourable when dry season is changing into rain in April and May, or rain season is changing into dry in September and October. The rate of infestation of larva usually reached 18. 0-39. 0% . The results of the larva feeded with 11 kinds of host plants were obviously difference in growth or the number of eggs. The rates of incubation and infestati on increased in the sugarcane fields of damp and water existence, because the activities of prey natural enemies in soil were influenced. By investigation, fifteen species of prey and parasitic natural enemies were discovered, but parasitic bee in egg was not discovered. It is favourable to reproduce and spread of the borer in the sugarcane fields of interplanting maize, cultivation over two years ratoon cane and plantion susceptible varieties in large areas. Rampant infestation world break out and cause considerable losses when misuse broad spectrum insecticides such as Furadan.

THE EXPERIMENT OF INTRODUCING ERICERUS PE-LA CHAVANNES INTO FUJIAN PROVINCE. Zhang Zaifu, Wang Yuannan, Lin Jingde, Gao Gangfeng, Gao Shanfa (Sanming Forestry Committee, Fujian 36500, China)

In 1985-1986, Ericerus pe-la Chavannes was introduced from Wanhe Town of Yongshan County in Zhaotong Prefecture of Yunnan Province into Yanqian Town of Sanming of Fujian Province. Wanhe Town is 1300 metres above sea level while Yanqian is only with an elevation of 200 metres. In Yanqian, Ericerus pe-la Chavannes was hung on Ligustrum lucidum Ait and grew in a smooth way. It has been determined: the average thickness of wax flower is 5.607 ± 0.272 cm; the amount of pregnant eggs reaches 5340.39 ± 1934.72; the sex rate between female and male is 1:3.04 ± 0.324; the melting point of wax is 82.7. Ericerus pe-la Chavannes not only produces excellent wax but also multiply its progeny well. The results show that Ericerus pe-la Chavannes can both multiply its progeny well and produce excellent wax in the areas with low elevation. Fujian Province has won its first success in some areas.

In 1987-1988, an experiment was made to test its survival in the most suitable places of Fujian Province. It was showed that Ericerus pe-la Chavannes could secrete wax and multiply well in different areas with high or low elevation.

STUDIES ON THE BIOLOGY AND CHEMICAL CONTROL OF ARBELA BAIBARANA MATSMNRA (LEPIDOPTERA: ARBELIDAE), AN IMPORTANT PEST OF LACCA HOST PLANTS. Wu Mu-de, Chen Xiang-jiao (Forest and Lacca Working Station of Fujian, Fujian 363600, China)

Arbela baibarana Matsmnra (Lepidoptera: Arbelidae) was one of main bore-trunk pests of lacca host plants such as Dalbergia szemaoensis Prain, D. balansae Prain and D. obtusifolia Prain in Fujian, and D. szemaoensis was most badly injured. The pest was also found to injure Dimocarpus Lour, Litchi chinensis Sonr., Acacia richii A.Br..

The pest had one generation a year and overwintered in the gallery with mature larva. It pupated in the late of March next year and the pupal duration was 28 days. In April, the adult emerged and oviposited its scale-like egg mass on the bark of the trees. The larva usually made a gallery through the bifurcation of trunk. The larva crypted in the gallery in daylight and fed on the bark at night. A larva could alimentate an average of 380 cm^2 bark with a maximum of 540 cm^2. Stopping up insect hole with the cotton soaking 300X 80 % D.D.V. emulsion could kill more than 98 % of the larvae in the galleries. Spraying 1000X 40 % Rogor to insect hole could kill more than 87 % of the larvae if plant trees were not bred by lacca.

A PRELIMINARY INVESTIGATION OF PEACH FLOWER BUD MIDGE (DASINEURA SP.). Zhang Limin (Agricultural Bureau of Yongtai County, Fujian 350700, China)

Dasineura sp. is a new pest of peach, which attacks the flower bud of peach and results in wilting of them. In the spring of 1990, the pest occurred severely, and the damaged rate of the flower bud reached 23-46 % in general, but a few harmful trees reached 100 % and no flower was on them.

The female adults lay eggs on the inside of the sepal with 4 mm cross diameter. Larvae injure the flower organization, suck juice and make the flower bud wilt and fall. There are about 15 larvae per flower bud, and 33 larvae to the maximum. The mature larvae spin their cocoons soon after they reach the ground. Duration of pupa is proximately 9 days.

Dasineura sp. injures the peach from the late of January to the early of April. The following measures are known to be effective against the pest: in winter, clearing and ploughing of the orchard to reduce the overwintering pest; during the peak of flower bud appearance in spring, application of insecticides on the tree crown to kill the adult before oviposition.

A PRELIMINARY STUDY OF OLIVE TUSSOCK MOTH (LYMANTRIA VIOLA SWINHOE) IN FUJIAN PROVINCE. Zhang Wan, Huang Qinqing (Agricultural Bureau of Mingqing County, Fujian 350800, China), Huang Bangkan (Department of Plant Protection, Fujian Agricultural College, Fuzhou, Fujian 350002, China)

The olive tussock moth (Lymantria viola Swinhoe), a serious pest in the olive growing areas along Ming River, developed 3 generations in Ming Qing County of Fujian Province per year. It overwintered with the egg stage on the trunk. The egg hatching peak of every generation just met with the olive shoot stages. A female laid 500-1000 eggs. After 3-4 days staying on egg mass, the hatching larvae moved to shoots and ate new leaves. The old instar larvae could eat 8-10 leaves per day.

The morphological descriptions of each stage, injurious characters and effective control methods to the pest are also given in this paper.

A PRELIMINARY STUDY OF THE LONGAN PSYLLID (CORNEGENAPSYLLA SINICA YANG ET LI). Li Yuezeng (Science and Technology Commission of Changtai County, Fujian 363900, China), Huang Bangkan (Department of Plant Protection, Fujian Agricultural College, Fuzhou, Fujian 350002, China)

The longan psyllid (Cornegenapsylla sinica Yang et Li) is an important pest on the longan, and is distributed in Fujian and Guangdong Provinces of China. The pest not only attacks the shoot and leaf of longan, but also is the vector of longan witches broom. It passes 3-5 generations a year and the generations overlap with the part diapause population. The nympha have 4 instars. Most population develop 3 generations per year, in which the 2nd instar nympha stop developing in August and then overwinter. But the 2nd instar nympha of part 4th generation stop developing in the late of September. However, a few grow into the 5th generation and its 2nd instar nympha overwinter in the late of November. Most nympha bring into action in the late of March next year, and adults and eggs appear in the early and middle of April. The appearance duration of the 1st-4th generations is from the late of May to the late of June, in the early and middle of July, the early and middle of September, and the early and middle of November, respectively. The peak of population within a year is from April to June. Its morphology and biology are also covered in the paper.

THE TRENDS OF PEST POPULATION AND THE STRATEGY OF IPM IN THE COTTON FIELD INTERPLANTING WHEAT. Hou-zhen Wang, Hong-liang Zhao, Jia-dai Su, Duo-xian Zhang, Zhi-men Gao (General Station of Plant Protection of Shandong Province, Jinan 250100, China)

Incontrast to the fields with cotton only. 1. The trend of main pest insect population: (1) Aphis gossypii Glover: For aphids injuring the young plant, the starting time of rolling leaves is 4 days later, the course of rolling is 56.6% shorter, the rolling leaves in the peak day were 72.9% less; For summer aphids, the begining of rolling leaves was 3 days later, the course of rolling leaves was 2.5 days shorter, the rolling leaves in the peak day is 7.94% less. (2) For Heliothis assulta Guenee, the total number of eggs of the second generation on 100 trees is 37.8% less, but the fourth generation was 90% more. (3) For Tetranychus telarius, the begining of red leaves is 4 days earlier; and the red leaves lasts 8.6% longer, in the peak day, the red leaves was 38.7% more. 2. The cause of changes in the trends of pest population. (1) More natural enemies: from June to August the total number of natural enemies on 100 trees was 49.3% more. (2) Nonbiological factors. Because of the natural defencive role of wheat, the aphids moving into cotton field later, also the lower temperature is unfavourable to the living and reproduction of Aphids gossypii Glover. the growing period of cotton interplanting wheat is 5-7 days later, therefore the second generation of Heliothis assulta Guenee would do less harm and the fourth generation do much. The room between rows of wheat is the hidding habitat of Tetranychus telarius, and with no pesticide sprayed before wheat harvesting is favourable to its reproduction. 3. The strategy of IPM: When contralling the pest insects living between the rows of wheat, it is important to protect natural enemies. The chemical insecticides are not sprayed in the cotton field before and after the harvest of wheat. The preparations of BT or controlled-release phosphorus insecticides dripping into the tip of cotton are used for controlling the second generation of Heliothis assulta Guenee.

A PRELIMINARY STUDY ON LIFE TABLE OF NATURAL POPULATION OF APHISII GOSSYP GLOVER. Guanghua Fan, Bingxia Liu (Agricultural Institute of DeZhou District, Dezhou, Shandong, 253015, China), Jiyuan Mu (Shandong Agricultural University, Taian, Shandong 271018, China).

Using the method of isolating generations, the Life table of natural population of Aphis gossypii Gover was studied in 1989-1990 and the data of 22 generations were obtained. The result showed that the weather condition and the natural enemy are the main factors which affect its popolation change. The function of the weather condition mainly included the unflexible casualty, injury of mouthparts and drowning caused by the wind and rain. The natural enemies mainly are lady beetles, green lacewings, predatory stink bugs, spiders, flower flies, plantlice braconids and parasitic fungi. K numerical value of the larva period of 22 generations demonstrated that the larva died mainly in the period of the second nd fourth instar larvae.

CHOICE AND APPLICATION OF THE MOST SUPERIOR METHOD OF FUZZY COMPREHENSIVE EVALUATION —— prediction on the population fluctuation of the second generation of the corn borer. Yao-nan Hua, Chong-zhao Hua (General Station of Plant Protection of Shandong Province, China 250100)

Based on the principle of Fuzzy muster and system analysis, 266 mathematical models — $\underset{\sim}{Y}=\underset{\sim}{X}\cdot\underset{\sim}{R}$ of Fuzzy comprehensive evaluation were designed. The weight coefficients of every factor (x_i) were defined according to their effect on the evaluation object (y). The 266 models were alternatively constituted of Fuzzy vectors $\underset{\sim}{X}$, which were composed of 19 methods, and Fuzzy matrixes $\underset{\sim}{R}$, which were made up of 14 methods, according to subjection degree of all factors to the every grade of evaluation object (y). The population fluctuation of the second generation of the corn borer in Lin'yi was predicted with the factor weighted and the added model —— $y_j=\sum_{i=1}^{n}(x_i\cdot r_{ij})$. The operator clear threshold in this evaluation function model was bigger. 27930 sets of datums were gained by operating 5586 year times. After effect inspecting, the historical coincidences reached 100% by the Fuzzy comprehensive evaluation mathematical model, which was differently consisted of the Fuzzy matrix R composed of contingency rate (θ) and Fuzzy vector $\underset{\sim}{X}$ made up of 12 fuzzy vectors. The most advantageous Fuzzy comprehensive evaluation mathematical model, or the method of Fuzzy interval weight and contingency rate was chosen by analysis of closeness dgree, precedence synthesis target and permutation precedence sequence. It possesses a practical value, and provides a new way to predict the population fluctuation of agricultural insects (harmful and beneficial) by the Fuzzy analysis.

STUDIES ON THE CONTROLLING STAGE OF MELOLONTHOIDS IN PEANUT FIELDS. Xie-song Song (Peanut Research Institute, Shandong Agricultural Academy of Sciences, Laixi 266601, China)

Grub has become a sort of severe pests in peanut fields in China since 1970s. Systematic studies on its controlling stapes were carried out during 1976-1990 with four periods.

The first period (1976-1978): Emphasis was put on controlling grubs (larvae) , which attacked the peanut seeds, pods and root systems. Various methods such as seed dressing, soil treatment and furrow application using phoxim etc, proved to be not good enough or even ineffective.

The second period (1979-1980): The control was made on both larvae and adults. But the methods were very complicated, thus couldn't be easily accepted by farmers.

The third period (1981-1985): Studies were concentrated on controlling adults. The method was covering seeds with systemic pesticides when sowing, applying pesticides to the soil surface around peanut clusters during growing stage.

the last period (1986-1990): the effective measure was demonstrated and extended.

ON THE MANAGEMENT MODELS IN THE ECOSYSTEM OF RICE-STRIPED RICE BORER { *Chilo suppressalis* (Walker) }
Wei-wen Wu (Department of Plant Protection . Southwest Agricultural University Chongqing , Sichuan 630716 . China)

The management technical system on the Rice-Striped Rice Borer (*Chilo suppressalis* (Walkrer)) Ecosystem was studied by setting five factors quadratic orthogonality (rotation) design of experiment . A series corresponding function models were established and evaluated by computer simulation . The input variables of these models included basic application rates of nitrogen (X_1) and calcium supperphosphate (X_2) . number of transplating seedlings per group (X_3) . the population desity of egg mass (X_4) and the leaf age when egg-hatching peak occured (X_5) .The output variables could be quantity of the rice tillerings , that of the dead hearts and leaf-sheath discolored stems and ratio of them to the rice tillerings , which could be outputed at the inferval every other five days , as well as at last quantity of rice ears and one thousand grain weight . the yield and its loss per hectare . The results of computer simulation showed that , in medium fertile field in Chongping , the yield of the middle-season hybrid rice could exceed 8100kg/ha by applying a combination of the following agro-techniques with the tolerance or overcompensation : bisic matura N 46 - 55.7kg/ha . calcium supperphosphat 376-407kg/ha . transplanting sedling 1.8-2 plants/group , populantion densisty 2066-2187 egg masses/ha . 8.7-8.8 leaf age when egg-hatching peak occured . Based on the change of system environment , the dynamic yield loss model , and the dynamic economic injury level , the damage boundary and the economic threshold models in first-generation borer were derived from the models mentioned above .

STUDIES ON THE OCCURENCE AND THE MANAGEMENT OF FOXTAIL MILLET WEBWORM IN SICHUAN PROVINCE

Pan Xuekian, Chen Kailu, Wang Yuanhong, Huang Fu
(Rice and Sorghum Research Institute, Luchou, Sichuan 646100, China)

Foxtail Millet Webworm *(Manpava bipuntella Ragonot)*, an important pest infesting sorghum in Sichuan, could complete development of one to two generations per year. The first generation infested corn and early planted sorghum from middle of June to the end of July and the second to the middle or late planted sorghum from mildde of July to end of August. Damage caused by the second generation was much greater than the first one. The diapause larva hibernate in the slits of wall, house or furniture. The adults prefered to lay eggs on the heading or flowering panicles of sorghum. The larva infested sorghum flower and grains. The occurence stage largely depended on the apperance of the photoperiod over 14 hour light and the temperature after June. The population of the pest greatly related to the overlap of the peak time of the adults to the time when the sorghum head and flower, temperature in June 10-30 and the planting areas of the late planted sorghum. The damage and occurence of the pests in Sichuan province could be divided into three districts: 1) the South Sichuan, where two generations occures, 2) The Middle Sichuan where only the second generation occures, 3) Northeast Sichuan where the pest caused little damage. Comparative analysis of the pest management measures indicated that hibernating control, early planting and sparying Shachon Shuang and deltamethrin at the late period of flowering can depress the pest population effectively. The index of chemical control was 150-200 larvas per hundred panicle.

THE DAMAGE AND CONTROL OF POTATO TUBERMOTH (GNORIMOSCHEMA OPERCULELLA ZLLER). Janheng Tan (Plant Protection Station of Wanxian District, Wanxian, Sichuan 634000, China)

Potato tubermoth G. operculella Zller (Gelechiidae: Lepidoptera), an important pest infesting potato in Sichuan province, mainly distributed in mountain and hill land areas. It can complete development of 5-8 generations in year. The pupa pupate and overwinter inside the tubers. The larvae bore into the leaves, buds, and the top of stems in the field, which induced the infection of fungi, bacteria and rot of the tubers. The efficient way to prevent the damage caused by the pest are as following: 1) Earth up potato crops to prevent the tubers from being revealed during the later growth stage of the crops, 2). Take the harvested tubers inside home before sunset and cover them with sand, rice hull, ash or plastic film to prevent from being oviposited on by the pests, 3). Spray By on the surface of the tuber heaps.

THE POPULATION DYNAMICS OF PLANTHOPPERS AND THEIR MANAGEMENT. Dunde Chen, Luibing Wang, Fangji Yang, Dagen Ai, Sifan Deng, Gong Xung, Yangqua Fang, Tongsheng Jiang, Ying Hou (Fuling Agricultural School, Fuling, Sichuan 648015, China)

The population dynamics of Nilaparvata lugens and Sogatella furcifera (Horcifera) as well as the strategy and economic threshold for controlling the pest were studied. The most harmful generation of the pests is from middle of July to middle of August, which is the offsping of planthoppers immigrated in the early time. The population increares linearly. The mixed population can be expressed $y=1232.3+60.2395x$. Sogatella furcifera $y=805.59+100.34x-3.1741x^2$, Nilaparvata lugens $y=-169.93+84.7835x$. Applaud sprayed in the first ten days of July can control the pests satisfactorily, with 81.33% mortality, no damage to benefit animals and with 16.73-17.58% of economic retrieval. Treatment on the other time eg. middle of June and end of July, however, can not control the pests effectively and economicly. Finally, the economic threshold for mixed population and single population of the two planthoppers were studied.

THE APPLICATION OF BT EMULSION AGAINST STRIPED RICE BORER AND RICE SKIPPER. Lin-ming Luo (Plant Protection Station, Sichuan Provincial Department of Agriculture and Animal Husbandry, Chengdu City, Sichuan Province 610041, China), De-sheng Wang, Tian-xiang Li (Agricultrual Technlogy Center of Mianzhu County, Sichuan Province 618200, China)

The use of Bt (Bacillus thuringiensis Berliner) preparation to control paddy rice insect pests was adopted only for a few years in Sichuan Province. The results of random block design experiments conducted in 1988-1990 showed that the control efficacy of Bt emulsion at the dosage of 1.5-2.25 liter/ha against rice skipper Parnara guttata (Bremer et Grey) was 80.04-86.39%, which was equal to that of diptrex at the dosage of 1.5 kg/ha; and the result of the mixtrue of 1.5-2.25 liter Bt emulsion and 0.75 liter 25% shachongshuang (one of the clam worm toxings)per hectare against striped rice borer was 93.15-98.27%, which was equal to that of 3 liter shachongshuang/ha alone. The use of Bt emulsion against paddy rice insect pests gave little affect on natural enemies, and the cost was 20-30% lower than that of chemical insecticides.

THE ESTIMATION OF THE YIELD LOSS BY PRIMARY PESTS OF TEA TREES.

Liu Yi-Qing and Xie Dong-Xiang (the Tea Research Institute, Sichuan Academy of Agricultural Sciences, Yong-chuan, Sichuan, 632160 China)

A preliminary study was conducted on the yield loss rate under diffrent pest densities of the two primary pests *Polyphagotursonmus latrs* Banks and *Emponsa* Flavens *Fabricius* in the alternation of generation overlapping. According to the result, the multiple regressional loss pattern is established on the reduced yield rate of tea tree to the pest densities of *Polyphagotursonmus lahes* Banks and *Emposasa flaveus* Fabricius $Y=-0.3702+0.6112X_1+2.9778X_2$. From the fixed economic threshold pattern I=C/M.P.E., the prevention and control index can be estimated when *Polyphagotursonmus latus* Banks and *Emposasa flavens* Fabricius occur in diffrent productive levels. It provides a strategic decision bdsis for the prevention and control tactius.

THE EFFECTS OF DIFFERENT INSECTICIDE COMBINATIONS ON THE INSECT COMMUNITY IN CITRUS ORCHARD. Jian-hua Tu, Wu-jun Zhang (Plant Protection Station, Sichuan Provincial Department of Agriculture and Animal husbandry, Chengdu city, sichuan 610041, Chian), Yue-qing Liang (Plant Protection Station of Pujiang County, Sichuan 610041, China)

The effects of inorganic, selective and broad-spectrum insecticide combinations, which were all effective in controlling the main insect pests of citrus such as the spider mites, scales, and moths, etc., on the insect community in citrus orchard were compared. There were significant differences among the four community parameters, namely, the richness, diversity, evenness and indeividual number, of the three treatments. Under the inorganic and selective insecticide combination treatments, the higher richness and diversity were maintained in the insect communities, while the dominant insect pest populations were reduced. Contrarily, the orchard with broad spectrum insecticide treatment contained fewest species and the individual number per species were most uneven, of which the dominant insect pests were very prominent.

STUDIES ON STRATEGIES AND TECHNIQUES OF CITRUS INTEGRATED PEST MANAGEMENT IN SICHUAN PROVINCE. Jian-hua Tu (Plant Protection Station, Sichuan Provincial Department of Agriculture and Animal Husbandry, Chengdu 610041, China)

The stratagies and techniques of citrus integrated pest management in sichuan province, china were studied from 1983 to 1989. The insect and mites pests on citrus could be divided into six categories according to their occurance frequency and injury level, of which mite, scale and moth caused serious damages on citrus. Focusing on these key pests and considering other secondary pests, a set of more effective IPM strategies was developed in view of insect community ecology. The effects of cultural, chemical and biological control methods on citrus insect communities were evaluated for developing an IPM system employing all suitable techniques and methods in as compatiable a manner as possible. And with respect to the difference of organization and structure in citrus insect communities, a set of IPM tactics, suitable for different areas, citrus species and growing stages, and seasons of a year, were developed. Practising this IPM system in main citrus growing areas of Sichuan Province proved its effectiveness and suitability.

THE DISTRIBUTION OF AMBLYSEIUS AIZAWAI EHARA ET BHANDHUFALCK AND ITS EFFICIENCY FOR CONTROLLING PANONYCHUS CITRI MCG. Hong-du Li, De-you Li, Qiong Ran (Plant Protection Institute of Guizhou Academy of Agricultural Science, Guiyang 550006, China) Lai-rong Liang (Biology Department of Fudan University, Shanghai, China)

It was defined that Amblyseius aizawai Ehara et Bhandhufalck was superior species among the nature enemies of Panonychus citri Mcg during a survey in 1988-1989, which distributed in Guiyang, Qingzhen, Zhenning and Dushan where elevation was at 1000-1300 meters. There were more mites in Guiyang and Qingzhen. The habit plants of the mite were Silphinm perfoliatumvl etc. 14 plants except citri. The results of protection and utilization and demonstration in two years showed that the damage caused by Panonychus citri Mcg could be successfully controlled by this mite, and the average population on each leaf would be reduced to less than one head. Without doubt, it will play a great role on controlling Panonychus citri Mcg.

THE INVESTIGATION OF POPULATION DYNAMIC OF EMPOASCA FLAVESCENS AND ITS EXPERIMENT FOR CONTROL OF PICKING TEA DURING THE GROWTH OF TEA SHOOT. Guohua Wang, Weiming Lin, Xhengbang Zhou (Guizhou Institute of Tea Sciences, Meitang 564100, China)..

The paper reports the investigation on tea Shoots of the 1-5 leaves, and analysed the structural change of populations. The results showed: In the productive the feilds where density of Population was low E. flavesces increased in index equation: $N=0.4066e^{0.1419t}$. And in the natural ones where density of population was high Empoasca flavescens increased in Logistic equation: $N=\frac{6.9561}{1+e^{1.7749+0.3345t}}$ The age consists of: Adult and egg were main in the first growth stage of tea shoots. Later, because egg hatched, adult and nymph were on the increase. The symbol of decrease was main in egg when density of populations reached saturation in the final stage. According to information, the standered of picking tea shoot and table on control efficiency were made within egg of E. flavescens and limit speed rate of the growth of tea shoots, which reached control efficiency among degree of picking shoots and egg of E. flavescens and speed rate of different growth of tea shoot picking tea shoots provided first proof of better systematic theory on E. flavescens. During end of autumn tea, control experiments of picking tea through keeping bud and tea shoots of one leaf two and three leaves showed: the higher degree of picking tea shoot was, the remarkable control efficiency was. Tea was picked through two treatments of keeping bud and a leaf shoots, population density of E. flavecens decreased gradualy during experiment, it plays a role on control.

A STUDY ON RADIATED STERILITY OF WILD SILKWORM. Rongxin Yang, Jiming Chu, Darong Xia and Weiping Gu (Institute for Application of Atomic Energy. Zhejiang Academy of Agricultural Sciences. Hangzhou 310021, China)

This is the first report on the research of radiated sterility mulberry wild silkworm (Bombyx mandarina Moore). The matured pupae of the insect were treated with 60℃ γ-ray. The emerging rate of the adult insects decreased with the increase of dosages. The correlation formula was $Y=87.26688e^{-0.0844x}$. The deformity rate increased with the increase of dosages and the formula was $Y=1.6921e^{0.7809x}$. The life-span of the male moths was not affected obviously within the dosage of 50 krad. The egg number oviposited was not influenced apparently within the dosage of 45 krad. The sterile rate of eggs increased with the increase of dosages. and the formula was $Y=93.0068e^{-1.0583x}$. The study of F1 on the effect of sterile inheritance treated by radiation indicated that the sub-sterile dosage for wild silkworm was 25 krad.

A STUDY OF GUANGXI REGION OF LOCUSTA MIGRATORIA MANILENSIS (MEYEN) . Qijing Yu, Wen Lu, et al (Institute of Biology, Nanning 530003, China)

In 1191, the calamity of Locusta migratoria manilensis in Hengxian, Guangxi, that was recorded firstly and 53 counties in Guangxi have been attacked by locust since then. Now the pests distribute in a few counties along three rivers: Hongshuihe, Liujiang and Qianjiang.

According to our research, the locust region in Guangxi should be divided into two types: waterlogging zone and reparian karst zone and we discuss their struction, formation and devolpment, we emphasize that the major reason of locust calamity is due to the last dry climate from September to December last year and from March to June this year.

IPM tactics which we put forward include 5 points, 1. greens planting on upper riparian mountains, 2. river management, 3. construction of agri-aqueduct works, 4. intensive monitor to the population of the 1st generation and control of the population of the 2nd & the 3rd generation.

THE STUDY ON A NEW INSECT-APHIS GOSSYPII GLOVER AND IT'S ECOLOGICAL CONTROL. Shi-qin Li (Protection Station, Agrotechnical Extension Center in Tulufan Area, Xinjiang 838000, China)

Aphis gossypii Glover moved to Tulufan from Chinese hinterland in 80 era. It caused heavy losses about 10 millions Yuan in 1986. Initially, spraying of chemicals were adopted, but the effect were very poor. It had certain effect of utilizing natural enemies and developed to ecological control in recent years. The eclogical control get rid of utilizing chemicals throughly. The main contents of the ecological control are: 1. Agircultural methods. 2. Artificial operations and physical control, 3. Traditional indigenous agricultural drugs, 4. Biological control-a vast amount of natural enemies have been moved in and multiplied for controling the economical losses caused by Aphis gossypii.

SYNOPSIS ON THE BIOLOGICAL OUTLINES OF LEAFHOPPERS (Homoptera: Cicadellidae).

Yi-shou Yin (Jiangxi Agricultural University, Nanchang 330045, China)

This paper deals with the biological outlines of leafhoppers(Homoptera: Cicadellidae) in China which divided briefly in ten items:

1. Feeding habits: All plant-feeding, closely related to agricultural production. More than a half polyphagous, nearly a half oligophagous or known only one host. Host range including herbaceous and ligneous plants. More than a half of them hosted in or mainly in herbaceous plants while the other parts are in or mainly in ligneous plants.

2. Habitation and damage symptoms: All in the above-ground parts of the hosts, mostly in the leaf blades and mainly on the back side; damage symptoms of three types, nearly a half of them of withering type, the other parts of curl-atrophy type and white-spot-shrivelling type respectively.

3. Voltinism: About 16% belonging to monogoneutic type, 84% belonging to polygoneutic type with fewer, more and many generations.

4. Wintering: Mainly as adults, eggs next, a few as nymphs together with adults. Wintering eggs in the tissues of the hosts, adults and nymphs scattered outside the tissues of the hosts in 4 type.

5. Occurring period and developing dates: In the middle and lower reaches of Changjiang River, the occurring period divided into the beginning developmental type of adults and the beginning developmental type of eggs; the developing dates divided into that of wintering stage and that of non-wintering stage, described respectively.

Finally, as to the occurring rhythms, egg-laying ways and locations,reproduction, aggregative habits and taxis are also described according to the appropriate references.

STUDIES ON THE BIONOMICS OF SCOTOGRAMMA TRIFOLII (ROTTENBERG) AND ITS CONTROL.

Zhanjiang Zhao, Enxiang Chen, Yi Zhang (Wuwei Institute of Agricultural Research, Wuwei 733000, China), Changjun He (Wuwei Forestory Department, Wuwei 733000, China), Xiulan Gao (Department of Plant Protection, Gansu Agricultural University, Lanzhou 730070, China)

The clover cutworm, Scotogramma Trifolii (Rottenberg), is a polyphagus pest which has 3 generations a year in Wuwei by way of the systematic feeding observations in laboratory and fields.

The first and second generation larvae damage pea , flax, alfalfa and broad bean etc. and the third one damages sugar beet chiefly where the pupae overwinter underground whithin 10-20 cm.. In the chemical control of this pest, 40% diazinon at the concentration 1:1000 and 40% shuianliulin 1:800-1200 with spary method were highly effective which resulted in a 90% mortality rate of the pest and the damage of plants went down by 56.9%.

The development zero and the total effective temperature of one generation are 9.6 ± 0.8 ℃ and 519.2 ± 24.7 day-degrees separately in laboratory.

GREY CATASTROPH PREDICTION ON PINK BOLLWORM (PECTINOPHORA GOSSYPIELLA) BY GM(1,1) MODEL.

Du-dong Wang, Zheng-xiang Ye (Institute of Plant Protection, Jiangxi Academy of Agricultural Sciences, Nanchang 330200, China)

The grey-system theory and method was used to study long-term prediction on pink bollworm. Through the processing of discrete data composed by 100-plant egg amount of the third generation P. gossypiella in Pengze,Jiangxi over the years of 1960-1986,and then simulated with differential equations, a long-term prediction model GM(1,1) of grey catastroph was set up. THe initial model was amended by its residual error ones. Thereafter, a predictive model of grey catastroph was at last obtained as $X(t)=53.60952 e^{0.17815(t-1)}+1.97246e^{0.03736(t-1)}-3.56687 e^{-0.19052(t-5)}-46.93949$. The coincidence rate of model forecast with historic data comes to 100%. Years in which pink bollworm would heavily occur in Pengze during 1987-2000 are predicted in the paper. The forecasted result for 1990 was completely coincided with the actual occurrence of the pest in that year.

REPORT ON TIBET ERIOSOMA LANIGERUM INTEGRATED RESEARCH .

Gangxi Zhang, Guang cheng Chui (Lhasa Plant and Animal Quarantine Institute of China, Lhasa 850000, China), Shulin Li, Xutang Liu (Forestry Bureau of Tibet, Lhasa 850000, China)

The pest, originally transported from India in China, now distributed in Yadong, Zhangmu, Lhasa, Linzhi and Milin, is a harmful insect in Tibet apple. It is located from the altitude 2100m to 3658m across two types of climate and is monophagous to Malus only. With the annual generations between 7-23, it begins to move about at 5.3°C in March and comes into dormancy at 4.7°C in Nov. In the period, the population goes as 'S' curve, no waves and no shift to other genus. The aphid spreads both initiative by crawl and winged aphid flight which happens in August and passive by man. Various kinds of apples have different resistant to parasite, it is proved that related to organ's structure and nutrition, as amino acid, vitamin ect. The systimatic managemant has achieved good results.

STUDIES ON THE OCCURING AND CONTROL OF SOGATA FURCIFER HORVATH

Gong Hang-lian (Ping-xiang Station of Plant Protection. Jiangxi, 337000, China)

Sogata furcifer Horvath is one important species of pest insects of rice in recent years in Jianxi province. There are six generations (rare in seven) in a year. Through the observation of given area from 1978 ~ 1990's. The relation between the date of immigranting and the number of occuring in paddy field: the more number of immigranting. the earlier appear in the field, the demage of the rice is more serious. S.furcifer generally damaged the early rice in the past years, but it also damaged the later rice and became more serious gradually after 1980. Comparing with the different date of the rice maturing, the early and later breeds of rice are damaged more serious. The test show that the more great the number of S.furcifer,the quantity of the honeydew which S.furcifer excreted is the more and rate of occuring of the rice sheath blight is higher. the index of this disease is greater and accelerate to wither the rice plant to the top. $rxy=Lxy/\sqrt{LxxLyy}$, $r=0.955$, $0.05> p> 0.01$. Integrated control: (1)Agricultural control: Raise the resistant breeds of rice; Augment the management of water and manure, Protect the natural enemy, Raise ducks to control the pest insects. (2)Chemical control: Suppressing the bursting and the former generation of the S.furcifer as the nymphs in 2-3 instar, with chemicals such as isoprocarb (MIPC), buprofezin (NNI-750) ect.

THE CHANGE OF CULTURE AND CLIMATE WITH THE OCCURRENCE AND THE CONTROL OF HELIOTHIS ARMIGERA,

Shixiong Wu (Institute for the control of Agrochemicals, Ministry of Agricutrue, Beijing 100026, China) Yuting Sun (Plant Protection Station of Linqing city, Shandong Province, China)

Besides resistance, the reduction of winter ploughing area, which is favourable for the overwintering of bollworm, the increase of the intercropping of grain and cotton and of the summer cotton, which are beneficial for the bread and transfering damage of the bollworm, increased the number of bolloworm and made them more difficult to control. The everage number of eggs per 100 plants in 1989-1990 is 3.215 times that of 1974-1981 for the second generation. For the fourth generation, the number of eggs increased to 1. 53 times. The meterological data of 21 years showed that the everage difference in temperature enlarged 7. 88℃, 7.26℃ and 7.11℃, in June, July and August respectively. Meanwhile, the ovipositing place of bollworm changed, and the number of eggs on the leaf back and bellow of plants increased. The existing ratio of insect in dry flower was 41.6-55% for the third generation, 60% for the fourth generation. The hatching larva from the eggs which laid on the subtending leaves enterred immediately into fruits and damaged them. Monocrotophos was supplied on the top of plant for the control of the 2nd generation. Monocrotophos or methorngl were sprayed from the both sides of the row for the third generation and "Nian Ling Bao" dust was also supplied.

A STUDY OF PREVENTING ASIAN CORN BORER IN NORTHERN AREA OF LIAONING PROVINCE. Guang-long Jin (Plant Protection Station of Tieling City, Liaoning 112000, China)

Asian corn borer (Ostrinia furnacalis Guenee) is one of the most serious insect pests. Drop in corn yield is due to annual damage of asian corn borer. The yield loss is about 10 percent, sometimes more than 20 percent. The experiments of control of corn borer was practised in recent years, the reasonable method was found. This paper describes that the method of artificial releasing parasitoid wasps (Trichogramma dendrolimi Matsumura is better than that of artificial throwing pelletized granule (one kind of insecticides formulation), and ecological environment is not spoilt.

STUDIES ON CUTTING OFF THE FOOD CHAIN OF PINK BOLLWORM PECTINOPHORA GOSSYPIELLA(SAUNDERS). Rong-hai Chen(Plant Protection Station of Anqing, Anhui 246001, China)

The damage had a direct relationship with the number of squares during the first generation (P<0.001). Excising square could suppress boll-boring insects. In 1985, squares appeared before the end of June, July 5th and 10th were excised, which resulted in shortage of food of first generatio larvae and death of boring larvae. The damage caused by the second generation was decreased as squares excised increased. While squares appeared before July 10th were excised, and insecticides were not applied to control second generation, the losses remained umder economic injury level. In 1990, all squares before July 5th were excised and second generation larvae were not controlled chemically. In control area where squares were not excised and pyrethroid plus chlorodimeform was applied three times at to control second generation larvae, the more squares before July 5th were excised, the more production was increased.

We made conclusion as follows:

1. Excising early squares can focus bloom and boll-bearing after plumrain-season, increase the number of effective bolls and the substance of giving up presummer bolls is that it can reduce the interior cotton caused by pink bollworm and boll diseases.

2. First-generation pink bollworm mainly damage the early squares. Excising early squares can reduce major source of boll-boring larvae and suppress or control the damage caused by second-generation. The results provide scientific basis for use of "de-square-agent" in large area to cut off the food chain of pink bollworm.

EFFECT OF LATE RICE AGRICULTURAL MICROCLIMATE DURING OCCCURRENCE OF BROWN-BACK RICE PLANT HOPPER. Xian-ju Zhen(Plant Protection Station, Wangjang County, Anhui Province, China)

Near 20 years the brown-bace rice plant hopper has been always main insect pest in submerge rice in China. They aggregate on the base of rice plants and little move after emigrating to rice fields. So special agricultural microclimate within rice plants has direct and great effect upon occurrence of the pest. Through investigation of 3 years, which is permanent sample plot and observing time from 20th of July to 31st of October 3 times per day katathermometer, we discover that effect from macroclimate on micro-climate is bigger before August, but become smaller after August; that microclimate is proper to generation and harm of the pest, however does macroclimate vary after late rice has tillered and growed. So insect pest population speedly improved. Two times of nymph number peak appear in third stage of August and Sepermber respectively. The two stage are also main controlling date. It is one of efficient means controlling the pest that changing agricultural microclimate ill-effect toward Brown-bace rice plant hopper by cultural practices, such as baking fields, rational manuring and selecting high-quality seed, etc.

STUDIES ON INTEGRARED CONTROL OF THE MAJOR INSECT PESTS IN SUMMER SOYBEANS. Chang-ju Xie (The Plant Protection Station of Anhui Province, Hefei 230031, China)

By means of studies on occurrence characterstics of the insect pests and their natural enemies in summer soybean fields, we have applied the integrated control to the main pests. The controlling ways are as follows: 1. Agricultural control. such as proper rotation of crops, rowing insect pest-resistant varieties and healthy cultivation(eg. applying fertilizer and watering during blooming date). 2. Integrated controlling or insect pests within different growing periods of the soybean. Between seedling and branching stage mainly controlling soybean aphid; Suppressing grubs, soybean stem borer (Melanagromaza sojae Zehnter) and the leaf-eating insect pests in blooming date; Pod setting stage controlling soybean pod borer and limabean pod borer. Control indexes: Grub (young stage) is 4-5 heads/m²; greenish yellow-brown hawk moth 8-10/100 soybean plants; Geometrid 80-100/100 soybean plants; Leaf-eating pests make stem borer per acre: seedling stage 15; flowering stage 100; pod setting stage 150. Limabean pod borer is 5-10 eggs/100 pods. Adult of soybean pod borers 40-55/100 plants. 5-10 eggs/100 pods. 3. Improving the techniques of pesticide application. Popularizing bio-control of insect pests, using biological preparations as Bt etc. Protecting and utilizing natural enemies to control insect pests in soybean fields, such as Telenomus sp. and Trichogramma, etc.

A STUDY ON THE MIGRATION OF COTTON LEAFHOPPER (EMPOASCA BIGUTTULA SHIRAKI). Yongnian Chen, Tong Pan (Hunan Agricultural College, Changsha 410128, China)

Cotton leafhopper (Empoasca biguttula (Ishida)) can not overwinter under the climate of Hunan. The eggs, nymphes and adnlts coexist over the winter in South China. Diapause stage was undetectable. The average supercooling point are -9—10℃ and -8.7—9.75℃ for the winter and summer individuals, respectively. The average moisture contents, total nitrogen, total sugar and crude fat are 59.1%, 1.93, 54.9 and 96μg/head for winter adults and 60%, 1.89, 54.0 and 95μg/heads for summer adults. Field investigations in 1985-1986 at 14 observation stations in 4 provinces (Guangxi, Hunan, Henan, Hebei) proved that there are synchronously in first appearances and sudden increases in different regions. Synoptic analysis of the long-distance migration showed two types of immigration. Some morphological differences exist between the emigratory and the local individuals (according to the ratio of the length of fore wing to hind leg). There is a certain daily rhythm and special take-off behavior.

STUDIES ON MEAN CROWDING BOTH BROWN PLANTHOPPER AND WHITEBACK PLANTHOPPER AND ITS APPLICATIONS. Shi Jianbo Lei Heizhi (Institute of Plant Protection, Hunan Academy of Agricultural Sciences, Changsha Hunan 410125, China)

The strength of aggregating (m^*/m) of distribution of Brown Planthopper (BPH) was higher than that of Whiteback Planthopper (WBPH), caused the aggregating behaviours by their themselves in the matter of adults and instars. The m^*—m regressive equations were: $m^* = 0.2763+1.2905m$ (BPH adults), $m^* = -0.2659 + 1.1379m$ (WBPH adults), $m^* = 1.1286+2.0544m$ (BPH instars), $m^* = 0.6714+1.1888m$ (WBPH instars). The strength of aggregating in the species was decreased with the uncompleted overlap of distribution of two rice planthoppers. The suitable sampling quantities of mixed populations have been proposed at the three densities. That's 57.7, 59.2, 48.3 at head/hill of 5, 2.5, 1 (BPH adults) and 1, 2.5, 5 (WBPH adults) and 89.6, 68.8, 48.0 at head/hill of 30, 20, 10 (BPH instars) and 10, 20, 30 (WBPH instars), respectively. The accuracy ($D = d/\bar{x}$) of the suitable sampling quantity depended on mixed populations was higher than that of sampling depended on single one.

TREND SURFACE ANALYSIS AND COUTOUR MAP TECHNIQUES FOR RICE PLANTHOPPERS POPULATION DENSITY AND FORECASTING. Shao-shi Li, Qi-yi Tang (Crop pests Forecasting station of Hunan, Changsha, 410127, China.)

Population density counts and the first day in macropterous adult catches of Brown planthopper or white backed planthopper in rice over 5 years were studied at multi-site of South China using geostatistical techniques of trend surface analysis. Map series of planthoppers population spatial distribution seasonal aspect and general planthoppers regional hazard maps were developed in Hunan province. Tendency map of the first adults capture day showing the possible migration path. Results and methods were useful to issue provincewide coutour map for planthoppers mean density long-term forecasting based on the result of time series (ARIMA) from many locations. Four maps contained in text.

PRIMARY RESEARCH ON THE OCCURENCE DYNAMICS OF RICE MAJOR INSECT PESTS IN THE VARIOUS ALTITUDE PADDY. Lan- xiang Wang (Crops Diseases and Pests Forecasting Station of Qian Yang Couty, Hunan, 418100)

There are 28500 mu rice paddy in Qian Yang County, most of paddy were distributed on the area altitude of 200-700M, the highest paddy altitude about 1200M. Since 1982, we spent 10 years to research dynamic occurence of major insect pests on the various altitude paddy such as 300M, 500M, 700M, 900M, 1100M. The results show: that overwintering in native land insects as rice stem borer (Chilo suppressalis), rice stem maggot (Chlorops oryzae) when they stay higher altitude paddy, their generation will be decreased, in the same generation when the paddy be higer for 100M, then the occurence period will be later 2- 2. 5 days. Migratory insects such as white backed rice planthopper (Sogatella furcifera), brown planthopper (Nilaparvata lugens), rice leafroller (Cnaphalocrocis medinais) will magrate to the various altitude paddy in the same time, but when the insects stay in various altitude paddy and its larva period will be different, the paddy altitude higer for 100M, the insects egg-hatched period will be later for 1-2 days, r= 0. 9934. Other results shw: that insects will be vertically migrated. The rice stem maggot (C. oryzae) its second gereration adult migrated to higer paddy, and in June -July then rice planthopperand rice leafroller will migrate to higer mid-rice paddy. In mid August will migrate to lower late-rice paddy.

RESEARCH INTO THE PREVENTION AND CURE OF CHINCH-BUG DIMORPHOPTERUS SPINOLAE (SIGNORET) BY LOW VOLUME SPRAYING FROM AEROPLANES. Zong-dian Wang, Xian-fu Shuai, Yang-chu Gong(Hanshou Institute of Reed Science, Hunan 415900, China), Fei Yan (Tian Xin Zhou Reed Farm, Nan County Hunan 413200, China)

Chinch-bug Dimorphopterus spinolae (Signoret) is very harmful to amur silvergrass and reed, and has cauded serioud problems in Hunan and Hubei province in recent years. The research result has shown that the proper dosage of 90% Dipterix and 80% DDVP is 1200-1350 grams per hectare, and the volumes of the both insecticides are 6000ml and 4050ml per hectare respectively when sprayed from an aeroplane. It has also shown that the key technical point of spraying Dipterix is to keep the temperature of solution over 45℃ in the aeroplane. The scheme of spraying is that DDVP and Dipterix are suited to spray when air temperatures are 25-32℃ and over 32℃ respectively. The spraying area reached 10300 hectares. the efficient more than 80%, and the loss retrieved about 6,200. 000 yuan.

APPROACH A WAY TO INTEGRETED PEST MANAGEMENT OF COTTON. Li Xian-jin (National Farm of Qian liang Lake, Yueyang , Hunan 414208, China)

When the structure of cotton bio-community was revised, the species of number of cotton insect pests and their natural enemies also changed following. So that the pest management of cotton should be changed following. There are four problems about management must be attended to as follow:(1) the system of cotton pest management should contains four subsystems, which may be fused the organization, the forecast informationm the supervisory implementy, and the substance supply. (2) To protect the natural enemies of cotton pests with the ideas of " cooperationsm", we must retain some pests to reproduce their natural enemies, to add to the dominant degree and the abindance degree of natural enemice, to pronote the crop growth well, to extend the time interval of natural control, and to apply the chemical control only at the late period of cotton growth. (3) When the forecasts of pest occurrence are carried out, we should apply the idea of" mutationsm". Don't spray insecticides at full fields or at full growth period, but growth, where or when the population density of pest increased over the economic injury level.(4) When the pest control would be carried out, we should apply the ideas of " theory of dissipation structure" to lead our actions. To control the pests at supper fore time, to kill the pests, with extend toxic action. When the energy and the substances of cotton fields are exchanged with the outside, we must retain their functional order, time order and space order.

STUDIES ON THE COMMUNITY STRUCTURE AND QUANTITATIVE DYNAMICS OF INSECTS IN LOW-PHENOL COTTON FIELDS. Hongying Ma, Ruiyun Zhao (Hunan Institute of Cotton Science, Changde, Hunan, 415001. China)

Systemic investigations were carried out on community structure and quantitative dynamics of insects in low-phenol cotton fields, and comparisions of the effect of different treatments (IPM area, chemical control area and CK) on them were made. The experimental results shown that frequence and relative abundance of cotton aphis. Aphis gossypii is highest, 100% and 93.7% respectively. And thus it is obviously a dominant species of pests in the fields. The next is cotton red spider, Tetranychus uticee, 84.61% and 5.18% respectively. On the other hand, of the natural enemies, Coleosoma actomaculatum is highest, 84.61% and 47.88% respectively, were varied with the growth of cotton plants. The deversity value is lowest in May and June, higher in July, slightly decreasing in August and highest in September. Of those treats effect of chemical control on community is the strongest. H' and E value show the same results, i.e., CK > IPM area) chemical control area.

STUDIES ON THE ECONOMIC THRESHOLD OF ENGLISH GRAIN APHID DAMAGING WHEAT. Huming Li (Department of Biology, Jishou University, Hunan 416000, China) Changshan Lin (Department of Biology, Peking University, Beijing 100871, China)

The field experiments that English grain aphid (Macrosiphum avenae F.) damaged the caged wheat were carried out. The analyzation results with computer manifest that the key time in which English grain aphid can damage wheat badly is the first 10 days of the milk stage of wheat . The economic threshold(ET) of English grain aphid are expressed with the aphid number accumulated day by day. (A) when "Yinshi-9" as parasitized, the ETs are 2402 aphids per 100 ears in the initial 5 days of the milk stage, 992 in the secondary 5 days of the same stage. (B) when "Jimei-19" was parasitized, the ETs are 1110 aphids per 100 ears in the initial 5 days of the milk-stage and 1845 in the secondary 5 days of the same stage.

BRIEF INFORMATION OF CHINESE GULLNUTS RESEARCH. Chunyiang Huang (Anjiang Argricultural School, Hunan 418100, China)

The distribution of Gullnuts is over southeast Asia area. It produced mainly in China. Discovery and applications of Gullnuts have over 2000 years in China. But, systematic research on it began in 1930's. There are 14 species of Gullnut aphids, 3 species of Summer wood hosts, 48 species of winter wood hosts. The ingredient of Gullnuts has applied for 20 more industry regions such as food industry, printing and dyeing industry, space travel, environment protection, pharmacy etc. The results of Gullnut research for a half century have been demonstrated that hope to realize good circle, and to attain the bumper harvest of Gullnut for long time, the main technical measures. Such as 1. select a good Gullnuts wood base and find correct ecological environments system for three factors of gullnut's growth and reproduction harmonically. 2. Well complete autumn migration, overwintering and spring migration. 3. control growth and rextrain natural enemy, reduce the Cullnuts bud falling, raise growing Gullnuts rate. 4. collect Gullnuts appropriately and reasonably, protect ecological envirounent of Gullnuts woods. I have research Chinese Gullnuts for several years, and success in breeding mother aphid and tempting mother aphid to ascend tree and to product gullnuts. This research results begin to apply in production.

ULTRA LOW VOLUM SPRAYING BY PLANE TO CONTROL WHEAT APHIDS IN JOINT-VILLAGE. Mingyi Chen (Station of Plant Protection and Quarantine, Daxing County, Beijing 102600, China)

From 1989 to 1991, ultra low spraying by plane were used to control wheat aphids,. especially in 1991 different villages were jointed together and pahids were coordinately controlled, which gained good efficiency.

5700 hectares were controlled in 1989, using 7.4 tons omethoate and DDVP, spending 163 thousand yuan, reducing 1.9804 milllion kg losses of wheat yield, reaching 92.7% controll efficiency; in 1990, 5730 ha were controlled, 8.75 tons, 188.9 thousand yuan, 2.2033 million kg, 96.7%; in 1991, 20 thousand ha, 31.5 tons 649.6 thousand yuan, 9.144 million kg, 96.9%, when 18 villages coordinatly took action.

INVESTIGATION OF INSECT PESTS ON ACTINIDIA IN HUNAN PROVINCE. Jian-ju Zou, Cheng-ai Zhou, Jun-cai Peng (Hunan Horticultural Research Institute, Changsha 410125, China)

During 1986-1991, insect pests and their important natural enemies on Actinidia were investigated in 12 counties (cities) in Hunan Province, where is one of three major actinidia growing areas in China. The results obtained showed there were 140 species of insect pests that belong to 44 families of 6 orders of insects as well as 38 species of natural enemies which belong to 14 families of 5 orders of insecta and families of parasitiformes of Arachnida. The important pests were scarabs (19 species), bettles (44), leaf hoppers (16) and scales (10), of which the most serious pests were as follow: Adoretus sinicus Burmeister, Microtrichia horishana N. et K., Apogonia cupreoviridis Kolbe, Holotrichia oblita Faldaerman (Scarabaeoidea), Aoria mucea Fairmaire of bettles, Erythroneura sudra (Distant), Empoasca flavessens (Fabricius), Empoasca rufa Melichar (Cicadellidae), Pseudaulacaspis cockrelli (Cooley), P. pentagana Torg., Aspidiotas destructor Sign. (Diaspididae). The damaged symptoms of Actinidia were observed and described. The most important natrual enemies were Chilocorus chalybeatus Gorham and Aphelinids. Also the pest-natural enemies communities on actinidia under different ecological conditions, the change tendency of the fauna and the dominant species with tree ages and seasons were investigated. Recommendation are given for pest control on actinidia.

STUDIES ON THE POPULATION DYNAMICS OF PIERIS RAPAE IN BEIJING SUBURBS. Suqin Wang, Juwen Wu, Baode Wang (Inst. of Plant & Environmental Protection, Beijing Academy of Agricultural & Forestry Sciences, P. O. Box 2449, Beijing 100081, China)

Investigations were made on the population dynamics of P. rapae in Beijing Suburbs during 1986-88. The results indicated that the regular occurring pattern of P. rapae changed with the changing of cropping systems. The previous doublepeak-type occurrence (in spring and autumn) no longer existed. Because of the sue of early varieties, the applying of early setting and plastic-sheet-covered cultivation, the spring-cabbage can be harvested before the occurring peak of P. rapae, this also limited the multiplication of the second P. rapae generation. The average number or larvae on per 100 plants was 34, which was lower than the economic threshold. Although the number of larvae on per 100 plants of the summer-cabbage reached 2126, the total number was still quite low as the area of the summer-cabbage was very small. It consequently resulted in the very low population base of P. rapae feeding on the autumn-cabbage, and there were no occurring peak of P. rapae at all on the autumn-cabbage.

STUDY ON THE METHOD TO SIMPLIFY THE DECISION OF THE SUITABLE TIME FOR PINK BOLLWORM(Pectinophora gossypiella) CONTROL WITH INSECTICIDES. Chun-an Fang, Guan-pei Nin (General Plant Protection Station of Hubei Province, Wuhan 430070, China)

Based on the ecological system of cotton, the authers have studied the relations among cotton, pink bollworm (an important pest in Hubei province) and its natural enemies, the function of the natural enemies, the self-replenish ablity of cotton, the spreading regularity of the pest, the loss of cotton, the ovipositing selection of the pest and its incursion acts etc.

On the above studies, the authers consider that the insecticides apply is the principal measure for pink bollworm control at present and the important control periods are during the second and third generation. As the development of the ecological study of pink boll worm, many researchers put forward the standard for control with the egg density on economical threshold, but it is difficult to carry in fields. For the practice and convenience, on the relationbetween cotton development and the egg density of the pect, from 1980 to 1982 we studied the correlation of cotton boll stage and the ovipositing and incursion behaviors, found that the cotton boll after blosom 20--30th days is the susceptible stage for the pest ovipstion and incursion. The fields demonstration in 1982 to 1984 showed that the most suitable time for chemical control was during the stage of four susceptible bolls per plant. This method has been popularized throughout the main cotton areas of Hubei province. Farmers said that the method is the best way to the decision of the cotton fields and time for insecticide apply.

INSECTS OF CRUCIFEROUS CROPS IN VENEZUELA. Pedro José Salinas (Universidad de Los Andes. Mérida. Venezuela)

A description is given of the cultivation of cruciferous crops in Veneruela from the beginning of the century up to present days. All the species cultivated in Venezuela are briefly described, as well as the main areas where the they are cultivated. Forty nine species of insects are recorded from cruciferous crops in Venezuela. The main pests of the cruciferous crops in the country are given, including nematodes, slugs and insects. The pests are classified in generalists and specific. A short description is given of the most important pests, the damage they cause, and their control. A list is given of the insects recorded in Brussel's sprouts, cauliflower, rape, raddish, cabbage, and chinese cabbage.

THE ARRANGEMENT OF SILICON BODIES IN LEAF SHEATHS AS A FACTOR OF BARLEY CULTIVARS RESISTANCE TO OSCINELLA PUSILLA MEIG (DIPT.,CHLOROPIDAE). E.A.Sinelnikov (All Union Institute for Plant Protection, 3, Podbelsky str.,189620, St.-Petersburg, Russia,USSR)

The deposition of silicon oxide in the sheaths of barley cultivars, two frit fly (O.pusilla) resistant and two susceptible ones, were compared. The modified spodogram method of Lanning et al(1958 was used. All cultivars essentially differ from each other by density of silicon bodies placing in the leaf sheathes. This character changed from 119 $\pm$5.5/mm^2 on the most susceptible cultivar to 225$\pm$7.8 on the most resistant one. The silicon bodies were placed in 1-2 rows along the sheath veins of the susceptible varieties as compared with 3-4 of the resistant ones. The addition of water soluble silicate to the soil decreased the stem injury by the frit fly larvae. Probably, the silicon bodies hinder the larvae penetration into the stems.

INSECT PEST MANAGEMENT IN VEGETABLE BRASSICAS WITHOUT INSECTICIDES. R G McKinlay (Scottish Agricultural College, West Mains Road, Edinburgh EH9 3JG, UK)

A lightweight, transparent fabric cover over cabbage plants ('floating mulch') has been shown to reduce significantly the damage from the caterpillars of some butterflies and moths (eg small cabbage white butterfly (Pieris rapae), cabbage moth (Mamestra brassicae) and diamond-back moth (Plutella xylostella)) and from the maggots of the cabbage root fly (Delia radicum); as well as the proportion of plants infested with aphids (principally cabbage aphids (Brevicoryne brassicae)). The cover appears to prohibit access to plants by flying insects. Slug activity and weed incidence may be increased however by fabric covers. The use of covers may be a reasonably practicable solution to the problem of managing migrant insect pests on organically grown brassica crops.

"EXACT ANALYSIS OF INTERCONNECTIONS IN THE SYSTEM APOIDEA-FLOWERING PLANTS"
N.N.Blagoveschenskaya (Ulyanovsky pedagogical institute,division of zoology,Russia), V.V.Blagoveschenskii, Ulyanovsky pedagogical institute, division of botany,Russia).

The system Apoidea-flowering plants has appeared in the process of attended evolution during several millions of years. The process of mutual selection in the direction of adaptation to each other of flowers and Apoidea took place all this durable time, in the form and texture of Apoidea (their proboscis, extremities, body and making the definite instincts, specialized colour sight and other adaptive peculiarities). The mutual adaptations sometimes go too far. The texture of flower and the texture of one or another group of insects may change so strongly (including behaviour reactions) that corresponding groups of Apoidea and of flowers cannot exist without each other. In this case there is the reason to speak about one or another degree of oligotrophism of Apoidea and of oligoapidophilia of plants.

STUDY ON THE REGULARITY OF OUTBREAK AND CONTROL OF THE COWPER BORERS. Qing-huai Luo, Hong-jin Wang, Xiao-yu Xiao, Ming Zhang(Guiyang Agricultural institute of science, Guiyang 550018, Guizhou, China)

Bean pod borer *Maruca testulalis* (Geyer) and bean butterfly *Lampides boeticus* (Linnaeus) are the most important pests in cowpea. The both have six generations each year and their generations overlaps seriously in field. They emerges from May to October (bean pod borer) or to Novrmber (bean butterfly). First to third generation (according to the beanpod borer), especially the second, do severe damage to cowpea and the percentage of bored pods is 20%—40%. during this period (June to Auguest). The larvae of bean pod borer constitue the overwhelming majorty of borers from May to July (98—88%) and decreased by a big margin after September. Bean butterfly larvae come up to 56.8% of total borers in September and 84.7% in November. The last (sixth) generation pupae of bean pod borer didn't be found in field and the ones that be raised at natural temperature died off in winter. So it was thought to be a migratory insect. Initial blooming stage of cowpea is regarded as the best chamical control time because the pod are not mature enough to pick after three times of insecticide spray (five day a time) and need no spray during the period about 12--16 times of harvest in general (2 days a time on the average). By contrast to the spray in full pod period, the damaged pods reduced by 61.8% and the yield lost decreased by 18.0%. The five and six generations needn't spray any insecticide again.

STUDIES ON FUNGUS GALL MIDGE OE OYSTER MUSHROOM IN HUNAN. Jia-wen Li (Hunan Agricultural College, Changsha 410128, China), Nanwu Chen (Hunan Institute of Microbiology, Changsha 410009, China)

The fungus gall midge Mycophila fungicola Fell. (Mycetophilidae, Diptera) , an important pest of edible fungi in Hunan province, can damage various cultivated edible fungi, especially Oyster mushroom. During the pest break out, there are too much midge larvae aggregated on a hymenium, and caused serious influence to the output and quality of Oyster mushroom. The distribution, hosts, demaged feature, paedogenesis, undercooling point, cold hardiness, larvae mortalilies under different combinations of temperature with realative humidity, and the effect of chemical control were studied. A larva may deposits 19-24 progenies. It is more beneficial to paedogenesis at the higher relative humidity of edible fungi cultural materials. When the larvae were reared on the extract of edible fungi cultural materials with water or on water dilute solution with a bit of Oyster mushroom hymenium. The larvae could survived and paedogeneted, but the development durations lessen 1.5-2. 5 days, reproduced progenies average decreased 68% and 57% respectively. Under the condition of temperature 19-26℃ and relative humidity 88-95%, the larvae can developed and paedogeneted successfully. The larvae have stronger resistance to unsuitable environment and can endured lower or higher temperature except aridity. The mortality of larvae is higher under the terrible dry weather. The larvae cann't develop successfully at 50% relative humidity of culture material. Undercooling point of overwintering larvae is -14.8 ± 0.67℃. When the bad weater comes, penultimate stadium midge larvae will overwinter or oversummer in the places such as patches, crevices or litters.

MAIN PROBLEMS OF FOREST ENTOMOLOGY IN SIBERIA. Yuri N. Baranchikov (V.N.Sukachev Institute of Forest, Siberian Branch, Academy of Sciences of Russia, Krasnojarsk 660036, Russia)

Scientific problems of forest entomology in Siberian region of Russia are developed in 7 institutes of Academy of Sciences, 4 universities and few federal research institutes in Tomsk, Ekaterinburg, Novosibirsk, Kemerovo, Krasnojarsk, Irkutsk Ulan-Ude, Khabarovsk, Vladivostok, Petropavlovsk-Kamchatsky. They deal with three main topics: forest insect fauna inventarization (FI), methodology of insect population monitoring and forecasting (MF), principles and methods of forest insects control (C). Inside each topic a set of projects is carrying out. FI includes the creation of lists of lokal insect faunas, identification keys and monographs on main pest species and ecological groups; MF - entomological and pathological classification of forested areas, based on physiography of stands and on forest type characteristics, improvement of sampling and remote sensing techniques, simulation modeling; C includes methods of biological and chemical control, studies on insect-plant relationships, genetics of plant susceptibility and selection of resistant varieties. For detailed information and future collaboration contact Siberian International Centre on Boreal Forest Ecology by the address given above.

BIOLOGY AND CONTROL OF SCALES ON CAMPHOR TREES IN TAIWAN. Ming-Jen Lee (National Chiayi Institute of Agriculture, Chiayi 60083, Taiwan, China)

Aulacaspis yubunikkei and *A. greeni* are important scales on camphor trees (*Cinnamomum camphora*) in Taiwan. The population dynamics of scales is remarkable. The scales may produce four or five generations per year. They start the first generation in late March. The second and third generations occur between April and June. Then, the fourth and fifth generations come during the period of August and November. Peaks of population density appear in two periods, i.e., from late April to mid-May, and late September to mid-October. During rainy season, the population density declines rapidly.

The scales can damage leaves, young shoots, and trunks of camphor trees. These damages may cause growth decline, yellowing, defoliation, as well as death of camphor trees.

Biological control with entomopathogenic fungi such as *Fusarium* spp. is recommended as effective measure to control the scales on camphor trees.

STUDY ON THE POPULATION DYNAMICS AND OUTBREAK PREDICTION OF MASSON-PINE CATERPILLAR. Qing-shan Zhao, Guo-ping Lu, Wen-bo Wu (Institute of Forest Plant Quarantine and Pest Control, Ministry of Forestry, P.R.China, 58 North Huanghe Road, Shenyang 110031, China)

Relationships among the population dynamics of Masson-pine caterpillar Dendrolimus punctatus Walker, one of the most destructive defoliators on hard pine forest in China, and the weather conditions, food source, natural enemies and periodical activity of sunspot were synthetically analyzed and mathematically inferred. The simulation model of population dynamics, and medium-long term outbreak prediction method of this insect pest were developed. The coincidence between the outbreak of D. punctatus and the high or low tide of sunspot occurrence was illustrated.

NEW DEVELOPMENT ON THE RESEARCH OF FOREST INSECTS IN SOUTH CHINA. Shu-fen Wang, (Central South Forestry College, Zhuzhou, Hunan 412006, China)

Most research and control projects of forest insects in South China are aimed at these pest insects of Pinus massoniana forests. In recent years, the emphasis of research on P. massoniana forest insects has been laid on ecology, population forcasts, control strategies and integrated management. The representative research contents are summerized as below: 1. Insect community research of P. massoniana forests: community composition, dominate species; classification of insect community types; community succession, diversities and stability. 2. Research on the ecological characteristics of three simultaneous defoliating pest insects- Dasychira axutha, Dendrolimus punctatus and D.kikuchii of P.massoniana. 3. D.punctatus eggs-egg parasitoids (Trichogramma dendrolimi, Telenomus dendrolimusi, and Anastatus albitarsis) interaction. 4. Mechanism of host marking, discrimination and acceptance of Telenomus dendrolimusi. 5. Epidemic dynamics of D. punctatus infecting Beauveria bassiana. 6. New techniques on forcast, decision-making and integrated management: decision-making expert system of D. punctatus; intelligent forcast system of D. punctatus; systematic forcast model of D. punctatus; mathematic model of influence of pine needle growth and loss on the wood volume growth; optimal decision-making model of D. punctatus integrated management and computer system of D. punctatus integrated management.

PRACTICAL MANAGEMENT STRATEGIES OF THE PINE NEEDLE GALL MIDGE, Thecodiplosis japonensis, IN THE FRONTAL ZONES OF ITS INFESTATION. Buom-Young Lee (Forestry Research Institute, 207 Chongnyangni-dong, Seoul, 130-012, Korea)

The damages of pine needle gall midge, Thecodiplosis japonensis, has been essentially confined to the frontal zones of its range advancement in Korea. The midge-caused tree mortality began to occur from the pine stands having 60% shoot mortality and increased rapidly from 80 % or more. The pine trees having less needles in comparison with stem volume were high harzard from the midge damage, and the major stand/site factors relating to the harzard-rating for the midge were ground covering with undergrowth, aspect, position of slope, stand density, slope and slope form.

The pine stands prior to the midge invasion needed to be thinned to promote the tolerance for the midge damage. Reducing damage in the population increasing phase after invasion, systemic insecticide implanted into trunk proved to be effective. Phosphamidon implantation of 60% of total tree numbers by one time application at previous year of peak damage showed below 30% in shoot mortalities whereas 81% in untreatment.

BIOLOGY AND CONTROL OF THE BLACK PINE BAST SCALE, MATSUCOCCUS THUNBERGIANAE, IN KOREA. Seung-Chan Park (Dept. of Forestry, College of Agriculture, Chonnam National University, Kwangju 500-757, Republic of Korea)

The black pine bast scale, Matsucoccus thunbergianae Miller and Park, was first found in the southwestern coastal area of the Korean peninsula in 1983. Since discovery, the scale has been expanding its range about 5 km per year damaging the forests of Pinus thunbergiana. It is a univoltine bisexual species which overwinters in the second instar. Adults emerge in early spring. An apparent obligatory summer diapause in the first instar was terminated by low temperatures.

Sixteen species of predatory arthropods have been found. Dense pine forests have been thinned before or during the invasion of the scale. However, it appeared that those natural enemies and silvicultural practices were not enough to evade serious damage in the frontal zone of infestation. Trunk injection of phosphamidon (Dimecron 50% Lq), 0.6 ml per cm D.B.H., treated in December caused 87.4% mortality of the feeding nymph.

STUDY ON RESISTANT GENE TYPES OF POPLAR TO LONGICORN BEETLE, ANOPLOPHORA NOBILIS. Xi-meng Wang, Quan-xiong Jiang, et al.(Ningxia Agricultural College, Yongning, 750105, China)

The resistant gene types are studied by the analysis of peroxidase isozymes using Polyacrylamide gel electrophoresis. It is shown from the study that among six analysed poplar species the most resistant one is Populus hopeiensis; the most susceptible one is P. nigra; while the peroxidase isozyme types differ with the resistant degrees of poplar trees. The resistant degrees are determined by their gene types but resistant species have characteristic band(stems, A_3, A_6, A_8 and B_9 ; leaves A_3 , A_5 , B_7 and B_9), while the susceptible ones lack in these band. The study provides a scientific basis for the early prediction of resistant properties in selection and breeding.

A STUDY ON THE PARASITES FOOD-WEBS OF DENDROLIMUS PUNCTATUS IN VARIOUS HABITATS. Jian-wen Peng, Bai-qian Li, Yun Jiang, Xiang-guan Dai(Hunan Institute of Forest Science, Changsha 410004, China)

The parasites food-webs of Dendrolimus punctatus are different in various habitats. There are 16, 67, 105 species hosts for Trichogramma dendrolimi and 7, 25, 44 species hosts for Pseudanastatus albitarsis and 8, 12, 19 species hosts for Casinaria nigripes in the purestand, in the sparse woods and in the mixed forest respectively. The food-webs of mixed forest are continue and very firm all the year round, especially in the layers mixed forest which is mainly composed of pines and oaks. The hosts of three parasites have 124 species altogether and are over 1/4 as many as lepidoptera insects in the forest. Maintainning proper populations can regulate and keep a balance in the forest. So it is not easy for Dendrolimus punctatus to come into calamity. Oaks are hosts of big and medium moths as Lasipcampidae, Lymantriiodae, Notodontidae. These moths are transport hosts of important natural enemies of Dendrolimus punctatus. To directionally close hillsides and to afforest pine-oak mixed forest can improve forest self-control ability to pest.

THE ROLE OF PINE SAWYER BEETLE IN PINE WILT DISEASE OCCURING IN FIVE-NEEDLED PINE STANDS. K. Futai, S. Shirakikawa (Laboratory of Applied Botany, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan), I. Nakai (University Forest, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan)

In our eary inoculation tests, some five-needled (haploxylon) pine species were susceptible to pinewood nematode, the pathogen of pine wilt disease. In Northeast Asia, there are five to six haploxilon pine species. Among them are *Pinus koraiensis*, *P. armandi*, *P. pumila* and *P. pentaphylla*. All of them grow at rather high altitude and thereby escape from the behavioral range of pine sawyer beetle, a vector of pinewood nematode. When these pine species distribute or being planted at low altitude as arboretum stands or as ornamental trees, however, are not safe from this disease infection. So, population density on each tree, and feeding preference of the vector beetle were compared between *P. koraiensis* and a susceptible diploxylon pine *P. densiflora* (Japanese red pine).

MONITOR AND POSSIBLE MANAGEMENT OF SCARABID BEETLES BY TRAPPING BAITED WITH PHEROMONE, KAIROMONE AND LIGHT. Akiomi Yamane (Faculty of Agriculture, University of Tokyo, Bunkyo-ku, Tokyo, 113 Japan), Takenori Shibata (Nitto Denko Ltd.,Koujimachi,Chiyoda-ku,Tokyo,102 Japan),Kenji Nagata (Sankei Chemical Company Ltd.,Kandatsukasa-cho,Chiyoda-ku,Tokyo, 101 Japan)

The white grubs,larvae of Scarabaeidae are well known as a major pests of forest nurseries. Since the ban on chlorinated hydrocarbon insecticides, management of white grubs has met difficulties, because of shortage of duration of alternative organo-phosphate insecticides. Black-light trap has been used for control and monitor of scarabids, but some of them are not attracted to the light. Recently pheromones and kairomones are available commercially for certain species, which will be able to supply each deficiency. Sex pheromone of the soybean beetle, Anomala rufocuprea , methyl(Z)-5-tetradecenoate,sex pheromone of the Japanese beetle,Popillia japonica,Nittolure,(R,Z)-5(1-decenyl) dihydro-2(3H)-furanone, and two kairomones, mixtures of eugenol, phenylethylpropyonate, geraniol, anethol, for various species, and black-light were used for field test. Specific pheromones successfully attracted target species, and kairomones attracted several species, including the Japanese beetle that doesn't respond to the light.Dominant species were the Asiatic garden beetle,Maladera castanea, the soybean beetle, the Japanese beetle and A.cuprea.

RECENT ADVANCES IN THE PHYSIOLOGY OF FOREST INSECTS IN CHINA. Huaguo Dai (Northeast Forestry University, Harbin 150040, China)

In China, the research in the physiology of forest insects began in the 1970s, and in the 1980s a geal of research works was done in this field, a lot of which were concentrated on the isolation, identification and synthesis of sex pheromones on the injurious forest insects with in Lepidopter and Coleoptera. In the field, tree resistance physiology, some advances were achieved in the resistance mechanism of poplar to Longicorn beetles and prominents. The research of the resistance of pine to Matsucoccus matsumurae kuwana is now also going on. In addition, the seductive function of plant sex seducements to the longicorn beetle and its digestion physiology are also being studied. Many reports on the analysis of proteins, isoenzymes and amino acids applied to classification of longicorn beetles, pine moths and aphids have been published. A relatively deep insight was gained in the physiological characters of overwintering larvae of Coleophora dahurica FIKv. in the deep cold region of Heilongjiang province and the cold tolerant larvae of Dendrolimus punctatus Walker in southern China. In the realm of the artificial forage of natual enemy insects and their breeding, the study of Trichogramma is occupying the leading position.

STUDY ON INSECT PESTS OF EUCALYPTS IN TAIWAN. Yu-Cheng Chang, (Taiwan Forestry Research Institute, 53 Nan-Hai Road, Taipei, Taiwan 100, China)

Field surveys on insect pests were conducted at several eucalypt plantations in North-Eastern, Eastern and Central parts of Taiwan. Four species of insects, viz., grape tree borer (Endoclyta sinensis (Moore)), white-spotted long horn beetle (Anoplophora maculuria (Thomoson)), Formosan termite (Odontotermes formosanus (Shiraki)), and coriariae leaf roller (Strepsicrates coriariae Oku) were considered as the most destructive pests on certain Eucalyptus spp.. The present paper discusses the damage and host plants of these four pest-species.

AN INDEX OF SUSCEPTIBILITY OF PINE STANDS TO PINE WILT DISEASE. Katsumi Togashi, Katsunori Nakamura, and Fumiki Takahashi (Department of Environmental Studies, Faculty of Integrated Arts and Sciences, Hiroshima University, Hiroshima 730, Japan)

Pine wilt caused by *Bursaphelenchus xylophilus* has heavily damaged *Pinus densiflora* and *P. thunbergii* forests in Japan. The degree of susceptibility of pine stand to the disease sometimes varies between stands even when they are closely located by each other. Using a simple time-delayed model of directly transmitted disease, a transmission coefficient was shown to be useful as an index of stand's susceptibility to the disease. It might be helpful to represent the effect of control techniques to the disease.

LOCAL CHANGES IN COMMUNITY STRUCTURE OF SUBCORTICAL INSECTS IN JAPANESE PINE FORESTS. Ken Yoshikawa (Faculty of Agriculture, Okayama University, Okayama, 700, JAPAN), Makoto Kasahara (Fac. Agric., Ehime University, Matsuyama, 790, JAPAN)

More than 30 species of beetles have been identified/documented as pine borers in Japan, the majority of them belonging to the Curculionidae, Cerambycidae, and Scolytidae. Since most of them are secondary pests which cannot attack healthy trees, the density of their populations is controlled primarily by food supply. An epidemic of pine wilt disease begun from the beginning of 1960's caused by the pine wood nematode, *Bursaphelenchus xylophilus*, has guaranteed them a continuously sufficient food supply. Adult subcortical beetles living in pine forests were randomly collected by traps with artificial attractants (α-pinene and ethyl alcohol) at 9 study points extending over 1000 km in Japan (N 35° 50'～N 32° 36') for all the year. Species composition and the relative abundance of each species showed relationships with the local environmental conditions affected by pine wilt disease. However the population level of *Monochamus alternatus*, the main vector of the pine wood nematode, did not show so much variation among study sites. The species interactions among the members of subcortical insect guild in pine trees were discussed on the differences in habitat, life history and body size of each species.

BARK BEETLE VECTORS OF THE PITCH CANKER FUNGUS (FUSARIUM SUBGLUTINANS) IN MONTEREY PINE (PINUS RADIATA) IN CALIFORNIA. David L. Wood, Joseph L. Fox and Carlton S. Koehler (Department of Entomological Sciences, University of California, Berkeley, CA 94720, USA), Kelli Hoover (Department of Biology, San Jose State University, San Jose, CA 95192, USA), Thomas R. Gordon and Mark E. Schultz (Department of Plant Pathology, University of California, Berkeley, CA 94720, USA)

Ips mexicanus and I. paraconfusus can transmit a fungal pathogen that causes pitch canker, a disease recently identified in Monterey pines in California. In Santa Cruz County, F. subglutinans was recovered from Ips spp. that emerged from pitch canker-infected P. radiata and were captured in multiple-funnel traps baited with racemic Ips spp. pheromones. Ips paraconfusus adults experimentally contaminated with propagules of the fungus transmitted it to seedlings and mature pines. Field transmission was demonstrated when cankers were produced following pheromone-induced beetle attacks on pines. Ips spp. inoculated F. subglutinans into pine slash, thus creating reservoirs of this fungus. Larvae, pupae, and young adults acquired the fungus when their parents were introduced into logs.

Conophthorus radiatae and Ernobius puctulatus (Anobiidae) emerged from naturally infested cones and captured in sticky traps carry propagules of this fungus. When artificially contaminated, they transmit the fungus to healthy cone whorls and to each other. These bark beetle species cohabited in 26% of infested cones. Observed first-year conelets were attacked by Pityophthorus spp. and C. radiatae.

IPS TYPOGRAPHUS, OPHIOSTIOMA FUNGI, AND DEFENCE OF NORWAY SPRUCE. Erik Christiansen, Halvor Solheim (Norwegian Forest Research Institute, Høgskoleveien 12, N-1432 Ås, Norway)

The Eurasian spruce bark beetle Ips typographus L. can kill millions of spruce trees during outbreaks. The beetle carries spores of several microorganisms externally and internally, among which are blue-stain fungi of the genus Ophiostoma. At least one of these, O. polonicum Siem., can kill healthy Picea abiea (L.) Karst. and other spruces when mass-inoculated into the cambial area.

O. polonicum occurs in phloem and outer xylem shortly after beetle mass-attack and remains at the leading edge of fungal invasion into fresh sapwood. This invasion obstructs stem water transportation and causes tree wilt. The fungus is well adapted to its pioneer role, being able to tolerate environments with very little oxygen.

Below a "threshold of successful infection" the fungal proliferation is arrested by an induced defence reaction, involving "secondary" resinosis. Secondary resin contains powerful fungistatic chemicals, as opposed to the "primary" resin from ducts in phloem and xylem. The induced defence is dependant on an effective translocation of photosynthate to the area of infection.

PARASITOID KAIROMONES FROM FUNGAL ASSOCIATES OF BARK BEETLES. Donald L. Dahlsten, Tom J. Eager (Division of Biological Control, University of California, Berkeley, CA 94706, USA), C. Wayne Berisford (Department of Entomology, University of Georgia, Athens, GA 30601, USA), Tom C. Harrington (Department of Plant Pathology, Iowa State University, Ames, IA 50010, USA).

Fungal associates which occur within the mycangium or on the body of bark beetles rapidly colonize host plant tissues when introduced into the trees attacked by bark beetles. It has long been hypothesized that the action of the fungi aid the bark beetles in colonization of the host tree, but our work has focused upon the interactions of the fungi and the higher trophic level, the parasitoids of the bark beetles. Parasitoids are not attracted to bark beetle brood until the brood has attained late larval stages. We inoculated sections of host tree with the associated fungi and use this material as a bait to capture associated insects in sticky traps. Field inoculation of host trees with bark beetle fungal associates produce significant catches of bark beetle parasitoids.

SYMBIOTIC FUNGI ASSOCIATED WITH *Xylosandrus mutilatus* BRANDFORD (COLEOPTERA: SCOLYTIDAE) AND THEIR SEASONAL OCCURRENCE IN WOOD. Hisashi Kajimura, Keiji Kanamitsu (School of Agriculture, Nagoya University, Nagoya 464-01, Japan)

The ambrosia beetles, *Xylosandrus mutilatus*, obtain their nutrition directly from ectosymbiotic "ambrosia" fungi cultivated in their tunnels. The fungi are carried by female adults in their specialized saclike organs termed mycangia and are then introduced into new host trees during gallery construction. We examined quantitatively the fungal dynamics in the gallery system and mycangia of the beetle in relation to its life history, by means of both isolation experiments and SEM microscopy.

In the galleries, *Ambrosiella* sp. was predominant during the larval growing periods but its relative dominance gradually decreased with development of the larvae. In contrast, yeasts (including several speices, e.g. *Candida* sp.) and *Paecilomyces* sp. continuously dominated in the galleries after eclosion. *Ambrosiella* sp. was consistently stored in the mycangia in all adult stages, except for the teneral and overwintering adults during which the other fungi were dominant. No fungal spores occurred in the mycangia of the adult beetles reared under aseptic conditions from the pupal stage, while only *Ambrosiella* sp. was stored in those from the teneral-adult stage.

THE ROLE OF ASSOCIATED FUNGI IN THE SUCCESS OF TOMICUS PINIPERDA ATTACKS ON SCOTS PINE. F. Lieutier, A. Yart (INRA, Zoologie Forestière, Ardon, 45160 Olivet, France).

A 4 year study on the success of attack by T. piniperda and its two associated fungi was conducted in Scots pine in the forest of Orléans (France). Under field conditions, T. piniperda always attacked a long time before tree activity began in spring. The presence of Leptographium wingfieldii was rare but constant in the attacking beetles, while frequency of Ophiostoma minus varied greatly, between plots in the same year. Inoculation of L. wingfieldii in trees induced a much larger defence reaction than a beetle introduction under the bark did. Indeed, 15 000 spores were necessary to induce a reaction significantly different from those induced by sterile water, suggesting that a beetle does not carry such a quantity. The size of an induced reaction resulting from a failed natural bettlee attack was not related to the presence of fungi in the gallery, but was correlated with gallery length. The success of each attack may depend on a threshold of the ratio "reaction length/gallery length". Our results suggest that : 1 - fungi do not play a role in the establishment of T. piniperda in pines (which do not exclude that they can kill the tree if the attack is successfull) ; 2 - tree reaction is induced by the mechanical stress due to insect boring ; 3 - beetle strategy is based on escaping that reaction.

CONTRASTS BETWEEN SAPWOOD DISFUNCTIONS ASSOCIATED WITH FUNGAL INOCULATION AND BARK BEETLE ATTACK IN PINUS PONDEROSA. John R. Parmeter, Jr., Garey Slaughter (Department of Plant Pathology, University of California, Berkeley, CA 94720), Kenneth R. Hobson, David L. Wood (Department of Entomological Sciences, University of California, Berkeley, CA 94720)

In Pinus ponderosa Laws (20-55 cm dbh) under natural or pheromone-induced mass attack by Dendroctonus brevicomis, a ring of non-conducting outer sapwood was detected by dye flow patterns within 2 weeks of attack. This ring gradually enlarged until, in trees 4-6 weeks after attack, all or most of the sapwood depth was occluded and crown symptoms (needle drooping and/or discoloration) were visible. Occluded sapwood was rarely bluestained, little resin was evident, and the advancing margin of the occluded ring was indistinct. In contrast, trees of similar size inoculated with bluestain fungi, Leptographium terebrantis or Ophiostoma minus, showed slower centripedal advance of sapwood occlusion, the non-conducting xylem was markedly resinous, and dye flow patterns were sharply defined. Trees inoculated with L. terebrantis through shallow saw cuts around the entire circumference at about 1.4 m failed to develop crown symptoms, even after more than one year, and the occluded xylem was, as with point inoculations, sharply defined, resinous, and of inadequate depth to simulate the occlusion resulting from mass attack by bark beetles. These observations suggest that the process of occlusion associated with beetles was basically different from that associated with sapwood colonization by bluestain fungi.

FUNGI ASSOCIATED WITH PINE-INFESTING BARK BEETLES IN SOUTHERN AFRICA AND THEIR POSSIBLE ORIGINS
M.J. Wingfield, B.D. Wingfield and C. Strydom. Department of Microbiology and Biochemistry, University of the Orange Free State, P.O. Box 339, Bloemfontein 9300, South Africa

Three species of pine-infesting scolytid bark beetles, believed to be of European origin, occur in Southern Africa. These include *Orthotomicus erosus*, *Hylurgus ligniperda* and *Hylastes angustatus*. Surveys of fungi from these insects have primarily yielded *Ophiostoma* spp. or their anamorphs including *Leptographium* spp., *Graphium* spp. and *Sporothrix* spp. Up to twelve species of the fungi have been found associated with a single insect species. These include well known taxa such as *Ophiostoma ips* and *Leptographium serpens* as well as numerous fungi yet to be described. Many of the fungi have been found on similar insects in Europe. However, surveys of fungi associated with these insects in their native habitats have not been thorough making comparisons difficult. The taxonomy of these fungi is also poorly defined which has led to considerable confusion. Molecular techniques are currently being used to characterize the fungi. Results for instance suggest that *L. lundbergii*, commonly associated with pine root-infesting scolytids in Europe, is conspecific with *L. truncatum* associated with similar insects in Southern Africa. This would solve one of the more curious anomalies relating to the Southern African situation. It is hoped that additional surveys of fungi associated with pine-infesting scolytids in Europe, as well as taxonomic studies, will lead to more meaningful comparisons between the mycoflora of insects in their areas of origin and in introduced situations.

HOST SPECIFICITY, MYCANGIAL FUNGI, AND TREE HYBRIDS: THE CASE OF *DENDROCTONUS JEFFREYI* AND *DENDROCTONUS PONDEROSAE*. T. D. Paine, Department of Entomology, University of California, Riverside, CA 92521, U.S.A.

Dendroctonus jeffreyi colonizes a single host pine, *Pinus jeffreyi*. *Dendroctonus ponderosae* is morphologically very similar to *D. jeffreyi* and has an overlapping geographic distribution. However, *D. ponderosae* has a much larger host range, including *P. ponderosa*, but not *P. jeffreyi*. The geographic range of the two pines partially overlap and the species will naturally hybridize. The focus of the study was to investigate interactions among tree species and hybrids, mycangial fungi, and the beetles to explain the evolution of monophagy in this mixed conifer system.

CRITICAL ATTACK LEVELS IN SCOTS PINE - A COMPARISON BETWEEN INDUCED ATTACKS BY *TOMICUS PINIPERDA* AND DIFFERENT INOCULATION DOSES WITH ITS FUNGAL ASSOCIATES. Bo Långström, Claes Hellqvist (Swedish University of Agricultural Sciences, Division of Forest Entomology, S-770 73 Garpenberg, Sweden) and Halvor Solheim (Norwegian Forest Research Institute, Section of Forest Ecology, Division of Forest Pathology, P.O. Box 61, N-1432 Ås, Norway).

Although *Tomicus piniperda* (L.)(Col, Scolytidae) is known as a secondary bark beetle seldom attacking living Scots pine (*Pinus sylvestris*), two pathogenic blue-stain fungi, *Leptographium wingfieldii* and *Ophiostoma minus*, have been found to be vectored by the beetle. The defence capacity of young Scots pine trees pruned to different crown size and vigour has been studied in experiments including induced beetle attacks and artificial inoculations with the two species of fungi.

Successful colonization by beetles occurred at attack densities exceeding ca 300 egg galleries per m^2 inner bark area, and the above-mentioned fungi were isolated from the the sapwood of killed trees. Tree mortality varied with pruning level and inoculation dose; one control tree out of 12 trees receiving 200 inoculations per m^2 died, whereas all 12 severely pruned trees inoculated with 800 inoculations per m^2 were killed, regardless of the inoculated fungus. At the intermediate dose (400 inoculations per m^2 *O. minus* appeared to be less aggressive *L. wingfieldii*.

Both fungi triggered a secondary resinosis in the inner bark and in the sapwood below the points of inoculation. The resulting lesions were larger for *L. wingfieldii* than for *O. minus*, and the inoculation-induced lesions were considerably larger than those produced in reponse to beelte attack. Failure to contain the beetles and/or fungi within the defens-ive lesions resulted in tree death. The percentage of non-functional and blue-stained sap-wood increased with the percentage of inner bark occupied by necrotic lesions. Tree vigour appeared less important for successful defence than the number of attacks/inoculations, i.e. any tree can be conquered if the beetles are many enough.

PHYSICAL DEFENCE AGAINST SOLITARY BARK BEETLES. D. Wainhouse, J.N. Gibbs (Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, GU10 4LH, U.K.)

The solitary European spruce bark beetle Dendroctonus micans attacks living spruce trees and may exploit the same tree in successive generations. This bark beetle has a high tolerance of resin but lignin in the inner bark cortex affects adult and larval behaviour and has a negative effect on the rate of larval development. Fungi that may colonise D. micans galleries are relatively little affected by the extent of bark lignification.

Lignin in bark, which unlike resin is unaffected by short-term environmental stresses, is an effective physical defence against solitary bark beetles adapted to attack living trees without the aid of symbiotic fungi.

BIOGEOGRAPHY OF DUTCH ELM DISEASE: XINJIANG AND MONGOLIA, CHINA, AND WISCONSIN AND CALIFORNIA, USA. M. M. Chen and J. R. Parmeter, Jr. (Department of Plant Pathology, University of California, Berkeley, CA 94720, USA), E. B. Smalley (Department of Plant Pathology, University of Wisconsin-Madison, Madison, WI 53706, USA), H. F. Yin (Department of Entomology, Chinese Academy of Sciences, Beijing, China), H. J. Liu (Near the Summer Palace, Chinese Academy of Forestry, Beijing, China)

For 10 years both Chinese and American forest pathologists have developed biological data on Dutch Elm Disease (DED) in four geographical regions. Since the late 1960's large-scale mortality of elms in Xinjiang and inner-Mongolia, China, has occurred. The Eurasian strains of C. ulmi are limited to Central Asia. American elms were very susceptible to all strains of C. ulmi. Different sources of Siberian elm exhibited different levels of resistance to strains of C. ulmi. In midwestern U.S., C. ulmi has killed most of the large urban elms. The smaller European elm bark beetle is the principal vector of the C. ulmi fungus in California where many American elms have been planted. A scientific analysis of the biogeography of the DED is crucial to understanding where and how the vector and the disease may become a problem and for the application of appropriate quarantines.

INSECT HERBIVORE POPULATION DYNAMICS: THE QUEST FOR SYNTHESIS. Peter W. Price (Department of Biological Sciences, Northern Arizona University, Flagstaff, Arizona 86011-5640, U.S.A.)

The identification of pattern in insect herbivore population dynamics is a first step in the development of general theory based on empirical facts. One pattern worth more investigation is a continuum in the dynamics of populations from those that are very stable or latent to those that are very eruptive - the outbreak or epidemic species. The first challenge is to find the position of general feeding types of herbivores, such as gallers, leaf-miners, borers, and free-feeders, on this dynamical continuum. When the pattern is identified, the mechanisitic explanation of this pattern needs development. Once the pattern and the mechanisms are adequately tested, and if supported, a synthesis on insect herbivore population dynamics may be achieved. This would form the basis for a factually based theory which unifies many presently disparate hypotheses on population dynamics. The need for this macroecological view is justified and the steps are illustrated in a tentative way using as extremes in the continuum stable populations of galling sawflies and the very eruptive forest pests such as spruce budworm and gypsy moth. The need to recognize strong influences of phylogeny and female behavior in this macroecological perspective are emphasized.

POPULATION DYNAMICS OF DENDROLIMUS PUNCTATUS AND DIVERSITY OF INSECT COMMUNITY IN PINUS MASSONIANA STANDS IN CHINA. Tian-sheng Li, Le-zong Ren(Research Institute of Forestry, Chinese Academy of Forestry, Beijing 100091,China)

Spatial and temporal simulation models of the population dynamics of Dendrolimus punctatas were established based on analysing and refining a great deal of research literatures about the pest. In putting experimental data of 1989 into computer showed the simulated results fitting well to natural conditions (the pest outbreaks every 3 or 3.5 years in natural conditions). which indicates the models established are good. In addition, the community in different conditions(different elevations and vegetation conditions) were compared. The results indicate that the community in the stands of higher elevation and better vegetion composed of more species and higher diversity indices. The communities of the stands in which the pest outbreaks have more species but with lower eveness and lower diversity indices than the stands under the same natural conditions in which the population donsities are very low.

THE JAPANESE PINE SAWYER AND THE SUGI BARK BORER, TWO SERIOUS FOREST PESTS IN JAPAN. Ei Shibata (Nara Forest Experiment Station, Takatori, Nara 635-01, Japan)

Adults of the Japanese pine sawyer, Monochamus alternatus, emerging from dead pines, carry the pine wood nematode, Bursaphelenchus xylophilus, which causes pine wilt disease of both Japanese black pine, Pinus thunbergii, and Japanese red pine, P. densiflora. As the adults then feed on branches of healthy pine trees, the nematodes enter the vascular tissue. Pine wilt disease is widely spread in Japan; annual loss of pines in 1981 amounted to 2 million m^3. The sugi bark borer, Semanotus japonicus, is one of the most important wood-injuring pests of Japanese cedar, Cryptomeria japonica, and Japanese cypress, Chamaecypress obtusa. It attacks the trunks of both tree species. Although cedar is seldom killed, timber quality is reduced considerably due to its feeding and subsequent invasion of wood rotting fungi which causes a type of damage called "hachikami". However, cypress is sometimes killed when horizontal larval galleries girdle the trunk. Recently, the incidence of heavily infested stands has increased in Japan. Thus, these two cerambycid beetles have become the most important forest insect pests in Japan. This study examined and compared the ecologies of both species, in particular (1)oviposition schedules, (2)survivorship curves and mortality factors within trees, and (3)adult population levels in the forest. Factors affecting the population dynamics of both cerambycids were compared and possible reasons why these species have become such serious pests are described.

NUTRITIONAL ECOLOGY AND POPULATION DYNAMICS OF THE WESTERN SPRUCE BUDWORM. Karen M. Clancy (U.S.D.A. Forest Service Research, Forestry Sciences Laboratory, Flagstaff, Arizona 86001, USA).

I have been working on a problem designed to determine the physiological mechanisms of conifer resistance to insect injury. The western spruce budworm (Choristoneura occidentalis) and Douglas-fir (Pseudotsuga menziesii) were used as a model system to address this question. My emphasis has been on testing the hypothesis that variations in the nutritional quality of Douglas-fir foliage are a mechanism for plant resistance to western spruce budworm attack. Numerous artificial diet bioassays were conducted to determine the importance of various nutrients (nitrogen, water, sugars, minerals) and allelochemicals (terpenes) as components of the budworm's "nutritional niche." The budworm's response curves to these nutrients and terpenes were compared to levels of the compounds in foliage from Douglas-fir trees that are putatively "resistant" versus "susceptible" to budworm defoliation. Several minerals and sugars appear to have important effects on budworm population growth, whereas terpenes did not have dramatic effects on budworm fitness.

INSECT PATHOGENS AND FOREST PEST POPULATION DYNAMICS: HOST PLANT QUALITY IS THE KEY. Mark D. Hunter (Department of Entomology, Penn State University, University Park, PA 16802, USA).

A number of forest insect pests have associated pathogens considered important in the population dynamics of the pest species. Like most natural enemies, however, the effects of pathogens on their hosts can change dramatically with variation in host plant quality. Simply put, there are three-trophic level interactions between insects, their pathogens, and insect host plants.

The gypsy moth has proven a useful species with which to investigate forest pest-host plant-pathogen interactions. Variation in tree quality among forest stands, among host plant species, and among individual plants within a species, all influence the efficacy of the gypsy moth nuclear polyhedrosis virus (LdNPV). Experiments in the field and laboratory have suggested a strong link between foliage chemistry consumed by gypsy moth larvae and their susceptibility to virus. Most recently, wound-induced changes in foliage quality caused by the gypsy moth on oak, have been shown to decrease further the efficacy of LdNPV, both within and between years. The result is an inverse spatial (and possibly temporal) density dependence, with increasing gypsy moth density causing a decrease in mortality from virus. This positive feedback should exacerbate gypsy moth outbreaks. Preliminary modeling efforts suggest that foliage chemistry can play an important role in forest pest-pathogen population dynamics and therefore forest pest outbreaks.

POPULATION DYNAMICS OF A GALL FORMING PSYLLID ON THE TROPICAL TIMBER SPECIES, MILICIA EXCELSA. Joseph R. Cobbinah (Forestry Research Institute of Ghana, Kumasi, Ghana), Michael R. Wagner (School of Forestry, Northern Arizona University, Flagstaff, Arizona 86011, USA).

Milicia excelsa is one of the most important timber species in subsaharan Africa between latitude 4°N to 12°S. This species is attacked by a gall forming psyllid, Phytolyma spp., which has so far prevented establishment of plantation of this valuable timber species throughout its distribution range.

Studies carried out in Ghana have shown that the dynamics of Phytolyma infestation depend largely on: 1) the distribution and abundance of tender young foliage with moderate to high total soluble nitrogen concentration, 2) physiological changes resulting from seasonal climatic changes and tree development, 3) variability in the degree of infestation of seedlings/trees growing in the same site.

On the basis of the impact of other management options and our understanding of factors influencing numerical fluctuations of Phytolyma, the main implication for management of the pest is the development of genetic resistance.

MATERNAL EFFECTS AND INSECT OUTBREAKS: TIME LAGS IN FOREST PEST POPULATION DYNAMICS. MaryCarol Rossiter (Departement of Biologie, Laval Universite, Ste-Foy, Quebec, CANADA G1K 7P4)

Recent theoretical work has focused on the impact of time-lags in density-dependent processes on insect population destabilization. Empirical work has confirmed the presence of delayed density dependence for a number of outbreak forest insect species. However, proximal causes of time-lags are still poorly understood. Data are presented to support the Maternal Effects Hypothesis of Insect Outbreak which states that environmentally-based maternal effects provide the proximal cause for time-lagged destabilization for some herbivorous insects by causing a delay in the density-dependent response to food quality in the parental generation. Using the gypsy moth (Lymantria dispar) as a model system, it appears that the nutritional experience of the parents has a significant influence on the quality of eggs produced by the mother, and egg quality influences the probability of survival and reproductive output, parameters critical to population growth. Immunological methods were employed to quantify vitellogin and other yolk proteins in individual eggs. The results suggest that these maternal egg products are the vehicle for delivery of environmental information on a time delay.

EPIRRITA AUTUMNATA AS A PEST IN MOUNTAIN BIRCH FORESTS. Kai Ruohomäki, Erkki Haukioja (University of Turku, Department of Biology, Laboratory of Ecological Zoology, SF-20500 Turku, Finland)

Data on outbreaks of the geometrid moth *Epirrita autumnata* have been compiled since the latter half of the 19th century. The data show that the outbreaks have followed 'cyclical gradient' or sometimes 'cyclical eruption' with the periodicity of 9-10 years. Data from the field indicate the importance of parasitoids in contributing to the cyclicity. Results of experiments with the mountain birch suggest that inducible reactions triggered by leaf damage may also be involved. Life history traits of *E. autumnata* originating within the outbreak range do not differ from those of *E. autumnata* outside the outbreak range. Therefore, outbreak potential cannot be explained by these traits. Nor have we found any adaptations to outbreak situations in outbreaking populations, although some of the characteristics may be advantageous for individuals during outbreaks.

SOME FEATURES OF BEECH CATERPILLAR OUTBREAKS AND BIOTIC AND ABIOTIC FACTORS INFLUENCING ITS POPULATION DYNAMICS. Naoto Kamata*,Yutaka Igarashi (Tohoku Res. Ctr., For. & For. Prod. Res. Inst., Shimokuriyagawa, Morioka, Iwate 02001, Japan)

The beech caterpillar, *Quadricalcarifera punctatella*, is a monophagous Lepidopteran species which feeds on beech leaves. Its outbreaks occur every 8 to 12 years and continue 1 to 4 years. Outbreaks do not randomize even though their terms of one outbreak and terms between two outbreaks are different on account of time and place. Defoliated areas move year by year, spreading horizontally like a belt with the width of about 200 m in the beech forest. Its population showed a typical gradation and fluctuated largely with 10,000 times of amplitude and with a period of 8 to 12 years. The population in the lower areas increased faster than those areas where outbreaks had been seen, but decreased before the outbreak. Hence in these lower areas, amplitude of oscillation was small and the phase preceded that in the area of the outbreaks. The phenomenon that defoliated areas moved every year could also be explained by delay of oscillation phase. Two biotic density dependent mortality factors played very important roles in decreasing density after the outbreaks. One was a carabid beetle, *Calosoma maximowiczi*, an arthropod predator. The other was a parasitic fungus, *Cordyceps militalis*, a kind of plant worm. The two species were very rare when a beech caterpillar was latent, however they increased as the prey (host) population increased. Both adult size and fecundity which showed close relationships with population dynamics should also be important factors causing fluctuation. The rainfall in July, when beech caterpillars spent most of the time in the larval stage, showed a close relation with the outbreaks, so it must be a factor dominating the long term and nationwide population dynamics of the caterpillar.

DIPRIONID SAWFLY POPULATION DYNAMICS. Michael R. Wagner (School of Forestry, Northern Arizona University, Flagstaff, Arizona 86011, USA).

Pine sawflies (Hymenoptera:Diprionidae) are major economic pests of coniferous forests throughout the world. Characteristics of population outbreaks for representative species from Asia, Europe, and North America are described. Nearly 75% of all diprionid species in North America can be classified as eruptive species. Sawflies have numerous adaptations that may contribute to the high frequency of eruptive species. The role of host plant resistance, sawfly modification of host resistance, environmental stress, site and stand conditions, plant architecture, and natural enemies in the population dynamics of diprionid sawflies is discussed. A generalized theory is presented to explain the high frequency of eruptive species within this taxonomic group.

PATTERNS AND EXPERIMENTS IN POPULATION CYCLES OF TENT CATERPILLARS. Myers, Judith H. (Depts. Zoology and Plant Science, University of British Columbia, Vancouver, CANADA, V6T 1Z1.

Tent caterpillars, *Malacosoma pluviale*, have ten year cycles in population abundance in western Canada. Characteristics of cyclic populations are: (1) high fecundity when populations are at the cyclic peak and decreased fecundity during several generations of population decline (2) prevalance of disease and parasitization in populations late in the peak and for several generations of the decline and (3) synchronous declines of populations with different histories , food plants and phenologies. Introduction experiments showed the resilience of the population dynamics. The role of sublethal viral disease and vertical transmission of nuclear polyhedral virus are currently being explored as influential mechanisms in the cyclic population dynamics.

SAWFLIES AS IMPORTANT DEFOLIATING INSECTS ON HIGH ALTITUDE PINES IN ITALY (HYMENOPTERA, SYMPHYTA). L. Masutti, A. Battisti (Institute of Agricultural Entomology, University of Padova, I-35131 Padova, Italy).

With the exception of the damage done to cembran pines by the larch bud moth during its periodic outbreaks in the larch-cembran pine forests of the European Alps, the most important defoliations which affect high-altitude pines in Italy are directly caused by sawflies and indirectly by lachnids and fungi.

The involved tree species are *Pinus cembra*, *P. mugo* and *P. leucodermis*.

The concerned defoliating sawflies belong to the families *Pamphiliidae* and *Diprionidae*. Some of them are found on two or all the considered hosts in diverse habitats. An interesting example is *Neodiprion sertifer* (Geoffroy) which feeds on *P. mugo* at low as well as high altitude; in the upper pine stands it takes two years to complete its life cycle both in the Alpine and Mediterranean mountain regions.

Sawfly larvae seem to be the commonest if not the only pine needle feeders in dry summer environments of the higher Central and Southern Apennines.

SEASONAL WATER STRESS: A NEW DIMENSION OF THE RELATIONSHIP BETWEEN STRESS AND SAWFLY OUTBREAKS. Joel McMillin, Mike Wagner (School of Forestry, Northern Arizona University, Flagstaff, AZ 86011, USA).

We studied the performance of Neodiprion gillettei on Pinus ponderosa subjected to different water stress treatments during either the root or shoot seasonal growth phase. Total instar survival and fecundity (from regression) were lowest on trees subjected to high stress during the shoot growth phase. Total instar survival and fecundity were highest on trees not subjected to stress throughout both root and shoot growth phases. Intermediate levels of stress during the shoot growth phase had lowered fecundity, but survival was not statistically different from the no stress treatment. Our results were therefore in contrast to the hypothesis that high levels of plant moisture stress lead to improved herbivore performance. Overall, high stress led to decreased sawfly performance when stress was applied during the shoot growth phase, while performance was unaffected when stress was applied during the root growth phase. The performance of N. gillettei differed among half-sib families of ponderosa pine trees. Fecundity was statistically higher on half-sib families having low to moderate root:shoot ratios than on a half-sib family with a 25% higher root:shoot ratio. This may indicate that differential response for both herbivore and host to high levels of stress is due in part to a genetic component in the host. In addition, examining root:shoot ratios under different levels of stress may be an useful tool in predicting population dynamics of defoliating insects.

A COMPARISON OF INSECT PEST PROBLEMS IN EUCALYPT PLANTATIONS IN AUSTRALIA AND IN SOUTHERN CHINA. F.R. Wylie, Forest Research Branch, Queensland Forest Service, P.O. Box 631, Indooroopilly Qld 4068.

Eucalypts were first planted in China more than 100 years ago, and the current plantation estate is about 670 000 ha, most of it in the southern Provinces of Guangdong, Guangxi and Hainan. These plantations are generally far healthier than those in Australia although a few serious problems have occurred. A total of 167 species of insect has so far been recorded damaging eucalypts in China, 13 of these being rated as serious pests and 8 as occasionally serious. The most important pest group is subterranean termites, notably species of Coptotermes, Macrotermes and Odontotermes. These insects have caused heavy losses in young plantings (up to 73% in parts of Guangxi). This situation is different from that in Australia where it is the older trees that are attacked. Other insects of importance on eucalypts in China are lepidopteran defoliators (Buzura, Carea, Chalia), a leafroller (Strepsicrates), larvae and adults of scarab beetles (Adoretus, Anomala, Exolontha, Lepidiota, Microtricha), and the gryllid Brachytrupes portentosus Lichenstein. The most serious timber pest is the longicorn Stromatium longicorne (Newman).

Potential threats to the Chinese plantations, based on the Australian experience, are discussed.

VISAUL ASPECTS OF CONE DETECTION BY CONE AND SEED INSECTS. Jean Turgeon (Forestry Canada - Forest Pest Mngt. Inst., P.O. Box 490, Sault Ste. Marie, Ontario, P6A 5M7, Canada)

Coniferous seed orchards have been established worldwide to produce abundant, frequent and easily collectable crops of genetically improved seeds needed for reforestation. Among the tools available to detect insect pests of cones and seeds are sex pheromone-baited traps and traps mimicking other stimuli (visual and/or olfactory) used by most species to locate host plants and/or reproductive structures.

The objective of this presentation was to review the research conducted recently on the response of some insects attacking cones and seeds [model insects: Diptera (cone flies), Hymenoptera (seed chalcids) and Coleoptera (cone beetles and pine cone weevil)] to visual stimuli with a particular emphasis on factors affecting their response. These factors included the physical properties of the stimulus such as spectral quality, shape, size and age, as well as biological parameters of the responding insects such as the species, sex and sexual maturity. The accuracy of traps mimicking visual stimuli in determining the time of adult emergence and predicting cone and seed insect potential damage was discussed. To conclude, the future use of such traps for the management of these insect pests, either as a monitoring tools or as a control tactic (mass trapping), was also addressed.

CONE AND FOLIAGE VOLATILES FROM DOUGLAS-FIR AND EUROPEAN LARCH: RELATIONSHIP TO ATTACK BY CONE AND SEED INSECTS. M.J. Jenkins (Utah State University, Logan, UT 84322-5200, U.S.A) and N. G. Rappaport (U.S. Forest Service, P.O. Box 245, Berkeley, CA 94701)

Volatile chemicals from cones and foliage of Douglas-fir (*Pseudotusga menziesii* (Mirb.) Franco) and European larch (*Larix decidua* Mill.) were captured using an effluvial trapping system and analyzed using capillary gas chromatography. Glass cylinders filled with Porapak-Q chromatographic substrate were attached to a vacuum pump with multiple inlet lines to trap volatiles, allowing simultaneous processing of large numbers of samples. Foliage and cone samples were taken throughout the final season of cone development for Douglas-fir, and correlations were made between susceptibility to *Megastigmus spermotrophus* Wachtl, the Douglas-fir seed chalcid, and monoterpene profile. Larch cone samples were conducted on cones that were attacked by two species of cone fly, *Strobilomyia laricicola* Karl. and *S. melania* Ackl.; for larch samples, correlations were made between monoterpene profiles and attack by the two species.

POPULATION DYNAMICS AND PROGNOSIS OF LARCH CONE FLIES (STROBILOMYIA MICHELSEN). IN NORTHEASTERN CHINA. Wen-sheng Yao,Shou-wu Jiao,Zhan-peng Li (Forest Tree Protection Station of Shandong,Jinan 250014,China)

Larch cone flies are the main insect pest of the larch cones and seeds in northeastern China.The population of larch cone flies is mainly regulated by the fluctuation of cone crop size.There is only one eggs in a cone when the cone crop is high and more than two eggs when the cone crop is low. Analysing the data from Gan-he and Song-ling Forestry Bureau, we conclude that annual fluctuation in the total number of third instar larvae per tree is corresponding to the variation in cone crop size.Using logistic equation proposed by Roques ,we established the whole population dynamic models for Gan-he and Song-ling.According to the two models,the cone fly population will remain static when the current cone crop size corresponds to 1 times the size of larval population present in the previous generation.By contrast,the population will grow or decline depending on whether more or fewer cones are available per larva respectively. Based on this conclusion , the forecasting equation of the damaged cone percentage is constructed. Using visual traps provided by Roques , we also constructed the forecasting model of the damaged cone percentage.

NOTES ON THE DISTRIBUTION AND BIOLOGY OF THE CONE AND SEED INSECTS OF LARCH, *LARIX DECIDUA*, IN THE ITALIAN ALPS. A. Battisti, N. Da Ros (Institute of Agricultural Entomology, University of Padova, I-35131 Padova, Italy).

The presence of the insect pests of larch cones in the Alps was checked through the sampling of 21 stands. The abundance of each pest species was correlated with both the altitude and the cone production of the stands. The maggot flies of the genus *Strobilomyia* Michelsen seem to be present in all the stands considered, causing the greater damage to the cones. In order of importance, they are followed by the *Cecidomyiidae* and by the *Tortricidae*.

Some biological features of the pest species found in the Alps were investigated in a selected seed producing stand by weekly samples. The sequence of colonization of the cones by these insects was the following: *Strobilomyia* spp. the first, then *Cecidomyiidae* and finally the *Tortricidae*. A preliminary analysis shows that the water content of the cone seems to affect in a very precise way the development of *Strobilomyia* spp. Other cone characteristics (e.g. size, previous insect attack) seem also to be involved in the colonization by *Cecidomyiidae* and *Tortricidae*.

PARENTAL AND GENETICAL EFFECT ON PROLONGED DIAPAUSE INDUCTION IN THE DOUGLAS-FIR SEED CHALCID, MEGASTIGMUS SPERMOTROPHUS. A. Roques, G. Roux (INRA - CR, Zoologie Forestière, Ardon 45160 Olivet, France).

Prolonged diapause is a characteristic pattern of population dynamics in most insect species that are specific to cones and seeds of conifers. These insects may extend their normal winter diapause over several years, up to 5 for the Douglas-fir seed chalcid. A negative relationship between the annual variation in cone/seed crop of the host tree population and the percent insects entering prolonged diapause has been clearly established. This adaptative mechanism thus allows insect species to survive in case of cone crop failure. Previous experiments lead to assume a tree effect on diapause induction through larval nutrition, chemical content of cones (seeds) being susceptible to vary with regard to the current cone abundance. However, some individuals emerge every year, irrespectively of cone crop variations. Laboratory and field experimentations have been performed on the Douglas-fir seed chalcid to assess the possible influence of insect genotype and/or the history of insect parents with regard to prolonged diapause. Aptitude to prolonged diapause seemed related to fecondation. Non-fecundated females (arrhenotokous parthenogenesis) only produced non-diapausing males. By contrast, fecundated females produced a mixture of diapausing and non-diapausing insects, the ratio varying with individual females. In this case, we showed a parental effect, parents exiting from prolonged diapause tending to produce a higher proportion on non-diapausing insects and conversely. Electrophoretic analyses have been also conducted on mature larvae and adults for a limited number of isozym systems to examine possible genetic differences. No difference were notices between diapausing and non-diapausing insects of the two groups. These preliminary results show that many factors related to host tree crop as well as to insect history are interacting in the global complexity of prolonged diapause.

MASSON-PINE CATERPILLAR (DENDROLIMUS PUNCTATA WALKER) POPULATION DYNAMICS AND ITS FORECASTING MODEL. Run-jie Zhang (Research Institute of Entomology, Zhongshan University, Guangzhou 510275, China)

Masson-pine caterpillar completed its development of three generations one year in Fengkai County, Guangdong Province. Its fourth or fifth instar larvae in the third generation overwintered in late December and recovered feeding activity in late February next year. There was a cycle with 3-4 years in its population dynamics. During the peak period, the density was 44.5 larvae per pine tree and that was 11.3 in other period. The growth index of the 1st, 2nd and 3rd generation were 1.1, 1.5 and 1.3 respectively.

The population dynamics was influenced by the following factors: the temperature in January, February and June, the rainfall in April, the relative humidity in July and the density of post-overwintering. It was shown that the transition probability of three status (serious, middle, and light) was 1, 0.73 and 0.5 respectively.

Several models were developed to predict the population tendency, including Markov chain model, stepwise regression model and time series model.

"HOW MUCH DOES KALTENBACHIOLA STROBI (DIPTERA: CECIDOMYIDAE) LOWER THE SEED QUALITY OF NORWAY SPRUCE?" A FINNISH CONSIDERATION.

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The effect of the spruce cone scale midge, Kaltenbachiola strobi (Winnertz) (Dipt., Cecidomyidae), on the development of the healthy seed yield of Norway spruce, Picea abies (L.) Karst., in Finland was investigated in 1990-1992. Seeds of the cones (female flowers), isolated against the attack of K. strobi in the spring 1990 (an excellent flowering of spruce), were compared with the seeds deriving from nonisolated cones of the same trees and branches. Comparisons of the quality of seed grains of attacked and nonattacked scales of the same nonisolated cones were also carried out. The results indicated that K. strobi, when exceptionally abundant (far over 200 larvae per cone in Northern Finland), greatly lowered the quality of the seed yield obtained.

BIOLOGICAL CONTROL AGENTS OF WORLD CONE AND SEED INSECTS. Harry O. Yates III, C.D. Tangren (USDA Forest Service, Athens, Georgia, USA), M. Skrzypczynska (Academy of Agriculture, Krakow, Poland), A. Roques (I.N.R.A., Adron, France), A. Bakke (Norwegian Forest Research Institute, Vollebeck, Norway), N.J. Mills (C.I.B.C., Ascot Berk, United Kingdom), J. Turgeon (Canadian Forestry Service, Sault Ste. Marie, Canada), and L. Mihajlovic (Faculty of Forestry, Beogard, Yugoslavia).

A worldwide survey of biological control agents attacking cone and seed insects has resulted in a list of over 500 species. These have been recorded in a computer data base along with the host species, distribution, synonyms, and literature reference for each biological control species. Reflex software provides easy access to the data.

SYSTEMIC INSECTICIDES APPLIED TO DOUGLAS-FIR CONE AND SEED INSECTS IN SEED ORCHARDS AND NATURAL AREAS. *J.D. Stein* (Pacific Southwest Research Station, USDA Forest Service, Berkeley, California, 94701 USA), R.E. Sandquist (Pacific Northwest Region, USDA Forest Service, Portland, Oregon, 97208 USA)

Three systemic insecticides–acephate, dimethoate, carbofuran–were implanted into Douglas-fir trees, *Pseudotsuga menziesii* (Mirb.) Franco, to evaluate their effectiveness to reduce seed and cone insect damage in seed orchards and natural areas in California and Oregon. Acephate significantly reduced seed damage by the Douglas-fir cone moth, *Barbara colfaxiana* (Kearfott), and a cone gall midge, *Contarinia oregonensis* Foote, and the treatment significantly increased by 300 percent the filled seed at the California site. Neither dimethoate or carbofuran significantly affected any of the seed or cone insects in this study, and acephate was ineffective against a seed chalcid, *Megastigmus spermotrophus* Wachtl, or the western conifer-seed bug, *Leptoglossus occidentalis* Heidemann.

DAMAGE AND BIOLOGY OF *PISSODES PINIPHILUS* IN ESTONIA
Anne Luik (Department of Plant Protection and Horticulture, Estonian Agricultural Academy, Tartu 202 400, Estonia)

In South-east Estonia about 2000 sparse pine (*Pinus sylvestris)* stands of 20-70 years of age are damaged by *P.piniphilus*. The stands grow on the poor sandy soils which at times are stressed by deficit of water and some nutrition components. Frequently the stands are weakened by *Bupalus piniarius* or by fungi *Heterobasidion annosum*.

P.piniphilus inhabits the pine trunks in the part of thin bark . The population density is very high on the trunk at the crown part (until 2529 larvae per m^2) where they also inhabit the branches. The survival rate of larvae depends on the physiological state of the host tree. If the resin pressure of the tree is high, then all the larvae perish in the young instars. On the weakened trees the mortality rate of larvae is 50-70%.The females lay the eggs over all the summer and larvae of different instars, hibernate. The supercooling points of the last instars larvae were in September -9,3...-11,5° C and in January -27...-35° C.

In the larval galleries the entomophages are rare. Most common among these are some *Braconidae*.

INTEGRATED CONTROL SYSTEM FOR THE SAKHALIN FIR APHID. Kimito Furuta (Laboratory of Forest Zoology, The University of Tokyo, Tokyo 113, Japan)

An integrated control system for the Sakhalin fir aphid, Cinara todocola, was proposed by Yamaguchi and Takai(1977). They recommended (1) silvicultural control measures in order to prevent a quick invasion of the aphids and (2) release of a parasitoid wasp for the prevention of the spreade of the aphids within a plantation. This control system has not been adopted practically due to the lack of the mass production system of the wasps.

It is, however, found that the same effect as the release of the wasps is expected in the way of the enlargement of between-tree distance within a plantation. The integrated control system has become easy to be adopted practically.

EFFECTS OF HOST-TREE SUSCEPTIBILITY ON THE POPULATION DYNAMICS OF GALL-MAKING APHIDS.
K. Ozaki (Forestry and Forest Products Research Institute, Sapporo 062, Japan)

The host-plant variation in the resistance to herbivore attack is important in dictating the distribution and abundance of herbivores. However, most life-table studies have ignored detailed information on plant resources variability. *Adelges japonicus* (Homoptera: Adelgidae) forms bud galls on its primary host, *Picea jezoensis*. The distribution of the galls per tree was highly aggregated in young plantations of *P. jezoensis*. To examine the genetic bases of this inter-tree variation in gall formation, I made an artificial plantation which consisted of two clones of grafted trees and inoculated *A. japonicus* population. The number of galls on each clone differed due to the different mortality rate of fundatrices in the overwintering period. There was also a large intra-clone variation in the number of galls, which was caused by low dispersal of winged adults between trees. These results suggest that the highly clumped distribution of galls is derived from the genetic differences in host-tree susceptibility in the overwintering period. The low dispersal of winged adults may result in the enlargment of this aggregation pattern.

LIFE HISTORY OF THE LODGEPOLE TERMINAL WEEVIL, PISSODES TERMINALIS HOPPING, IN LODGEPOLE PINE IN ALBERTA, CANADA. David W. Langor, (Forestry Canada, 5320 - 122 St., Edmonton, Alberta, T6H 3S5, Canada)

The phenology, behaviour, and survival of Pissodes terminalis Hopping was studied in young lodgepole pine, Pinus contorta Douglas, stands in west-central Alberta from 1989-92. The life cycle of the species spans two years. Adult weevils overwinter on the ground and emerge in late spring to disperse by flight and reproduce. Eggs are laid in the current year's terminals. Larvae feed in the phloem for 1.5-2 months and then enter the pith to continue development. Feeding of the larvae kills the terminal leader. Late instar larvae overwinter in the pith. Development continues in the following spring. New adults emerge in mid-summer, feed for several weeks, and move to the ground to overwinter. A cohort is produced each year. Major mortality agents are entanglement in resin, parasitoids, and winter exposure. Total mortality from egg to adult varied from 93% to >99%. The variation in the life cycle of P. terminalis over its range is discussed.

THE CONTROL OF SOIL PESTS OF ESTABLISHMENT OF PINES, EUCALYPTS, AND WATTLE IN SOUTH AFRICA.

P. R. Atkinson, The Institute for Commercial Forestry Research, Pietermaritzburg, South Africa.

There are now some 600,000 ha of pines, 500,000 ha of eucalypts and 100,000 ha of wattle in commercial plantations in South Africa. In the last seven years the area under forestry has rapidly expanded mainly by planting eucalypts, when a serious pest has been the fungus-growing termite *Macrotermes natalensis* Haviland. *M. falciger* and *M. mossambicus* are also involved north of 26° S latitude. The mortality of transplanted trees can reach 80%. Two instectices have been registered: carbosulfan 10% controlled-release granules applied at 1.0 g active ingredient per tree around the root plug at planting; and chlordane 60% emulsifiable concentrate applied at 0.6 g a.i.in one liter of water per tree. Resistant eucalypt species are a useful alternative at low rates of attack and tend to belong to the subgenus Symphiomyrtus, section Maidenaria, series Viminales. Susceptible species tend to belong to the subgenus Monocalyptus.

White grubs (Scarabaeoidea) are troublesome at middle altitudes (1000-1300 m) in Natal and the south-eastern Transvaal in sites previously planted to wattle (*Acacia mearnsii* de Wild.), sugarcane or grassland, where losses may be 10-20%. The most serious species is *Hypopholis sommeri* Burm., but species of *Schizonycha*, *Anomala*, *Monochelus*, and *Adoretus* are also important. Gamma BHC 0.6% dust at various rates has been used but is not registered and there have been reports of failures. However, recent trials confirm that this treatment is effective at 0.06 g a.i./tree, and is by far the cheapest although several other chemicals were as effective.

Cutworms (*Agrotis* spp.) are widespread pests of eucalypts and wattle, causing up to 10% mortality of transplanted trees, especially where weed control is poor. Gamma BHC dust is ineffective and a priority of of current work is to find a single treatment to control both cutworm and white grub at planting. Deltamethrin 5% suspension concentrate at 0.05-0.10 g a.i./tree is the cheapest treatment so far identified which is effective against both pests.

Nematodes have not been definitely implicated as pests although in two situations they have been suspected: eucalypts planted on weak coastal sands, and pines planted on ex-maize lands.

The bark beetle, *Hylastes angustatus* (Herbst), may be a pest of pine transplants in certain regions and is commonly treated with gamma BHC 0.6% dust at 0.03 g a.i./tree around the stem at planting but this is not registered. Its status as a pest, and its control, need to be confirmed.

CAN *HYLOBIUS*-DAMAGE TO CONIFER SEEDLINGS BE REDUCED BY PLANTING IN LATE SEASON? Bo Långström (Swedish University of Agricultural Sciences, Section of Forest Entomology, S-770 73 Garpenberg, Sweden)

Seedling mortality resulting from the stem-gnawing by adults of *Hylobius abietis* (L.) (Col., Curculionidae) and related species is a major problem in reforestation areas in Sweden and elsewhere in temperate regions, where forestry is based on clear-fellings followed by conifer plantations. The key problem is the coincidence between high weevil abundance in the reforestation areas and the presence of newly planted seedlings in physiological imbalance, and hence sensitive to all sorts of damage.

Knowing the life cycle and the seasonal feeding pattern of *H. abietis*, certain periods during the first years after the final felling should be less risky for the seedlings than others. In a pilot study, large differences in survival were obtained for one-year-old seedlings of Scots pine (*Pinus sylvestris*) by selecting the the best possible planting time with respect to seasonal weevil activity. Additional studies revealed that planting in late summer, when weevil activity in general is lower than in early season, resulted in improved seedling establishment and better resistance to *Hylobius*-damage than traditional spring planting. Thus, the possibilities to use late season planting as one component in an integrated pest mangement approach to control weevil damage, shows some promise at least in Central Sweden, and should be studied under different conditions.

STUDY ON THE MODEL OF CONTROL INDEX FOR COLEOPHORA DAHURICA FIKV. Liyuan Jin (Yichun Academy of Forestry Sciences, Heilongjiang 153000, China)

At present, there are a lot of information on the pest control index in agriculture and forestry, but in the reports about study on the control index of larch casebearer (Coleophora dahurica), the writer only found the index for using once, the control index model for long-term use has not been found. The writer conducted further survey and did measurements and statistics on the average weight per needle and the average weight of the needles per shoot in unit length, as well as the average needle number per cluster based on the previous studies on the measurements of needle weight in different larch stand, the effect of needle losing amount on volume losing amount, and the measurements of feeding amount by larch casebearer. According to 6 direct parameters and 6 related indirect parameters, the control index, model of this pest was developed as follows:

$Et=[(c/p)/a]^{\frac{1}{b}} \div Nx0.01ex0.01D$

Where, ET: control index (number/m), C: total contral cost (yuan/ha), P: timber price (yuan/m), e: efficiency of control method (%), D: percentage of damaged trees (%), N: standard numbers of shoots per tree, a, b: power-law regression coefficient of the maximum carrying capacity for the insect per tree (number/tree) related with volume losing amount (m/ha) . There are two formula for the model in calculating spring control index and whole year control index. It is not necessary to think over the different stand density and damage days in applying.

ECOLOGICAL SIGNIFICANCE OF THE FEEDING PARTS IN ARTHROPODS AND STUDY TECHNIQUES. Ujjal Singh Bhatti , **Vijay V. Singh** (Department of Zoology, I. P. Degree College (Meerut Uni) Bulandshahar (U.P.), 203001, India)

A careful examination of the skeleto-muscular and neural constituents of feeding appendages and or equipments often yield a great deal of information, as to the ecological significance of the organisms bearing them (Bhatti and Sharma, 1991). This very study has not as yet been extensively made (Joan & Frank, 1984); this is especially true for the Indian arthropod fauna. This study attempts to pin point the morpho-anatomical specifications of the feeding organs in micro- and macro-arthropods inhabiting in the aquatic as well as terrestrial ecosystems and belonging to all the major classes of phylum Arthropoda. Plumose setations and or flat grinding mandibles are associated with herbivorous species, whereas the carnivores are armed with apiny, widely spaced and carinate mandibles-in the micro-arthropod species.The study techniques involved: preparations of the permanent whole mounts, section cutting in T.S. and L.S. of animals or their exuviae or limbs. Manipulations of the limbs or animals is simplified in a viscous glycerol medium/polyviny lactophenol.

POTENTIAL IMPACT OF WHITE PINE WEEVIL ON JACK PINE AND MANAGEMENT IMPLICATIONS USING STAND MANIPULATION Sandy M. Smith, (Faculty of Forestry, University of Toronto, Toronto, Ontario, Canada, M5S 3B3).

The white pine weevil, *Pissodes strobi* (Col.: Curculionidae), attacks the terminal stem of young conifer trees during regeneration. This can result in reductions in volume as well as aesthetic and structural qualities of the wood derived from the mature tree. Over the past 4 years, my research group has been investigating the impact of terminal loss on jack pine (*Pinus banksiana*). Mature trees were selected based on their external condition, milled, and assessed for number of pith disruptions (terminal losses) and resulting volume and quality of lumber. There was a 13% reduction in commercial value of damaged trees compared to undamaged trees, suggesting that the weevil has the potential for economic impact on young jack pine and should be controlled at least at a minimal level.

Research is ongoing to determine whether populations of white pine weevil can be influenced by manipulating young jack pine stands (5-10 year old). Plantations which had been either aerially seeded at dense spacing (10,000 trees/ha) or hand-planted at 2 X 2 m spacing (3,500 trees/ha) were sampled for the number of weevils and attacked leaders, insectivorous birds and mammals as well as tree distribution (clumped vs uniform) to relate stand parameters to weevil survival and population dynamics. This relationship was quantified using cages to exclude natural enemies in these 2 different stand types. The present paper discusses the implications for weevil impact on jack pine and the potential for changing stand density to augment natural weevil mortality and reduce the economic impact of this pest.

AN OUTBREAK OF THE CRYPTOMERIA BARK BORER, *SEMANOTUS JAPONICUS* LACORDAIRE (COLEOPTERA: CERAMBYCIDAE). K. ITO and K. KOBAYASHI (Kansai Research Center, Forestry and Forest Products Research Institute, Momoyama, Fushimi, Kyoto 612, Japan)

The cryptomeria bark borer is the most important wood-damaging insect of two major commercial conifers in Japan, Japanese cedar (*Cryptomeria japonica*) and Japanese cypress (*Chamaecyparis obtusa*). Borer larvae feed on the phloem and wood of the trunk of living host trees, causing serious deterioration of timber quality and occasional mortality. We have monitored adult emergence holes of a borer population infesting a young cedar plantation.

The borer established its population in the study plantation 5 years after planting. It increased continuously in number and reached a peak abundance (about 34,000 adults/ha) 6 years later, and subsequently kept declining rapidly. The number of damaged trees amounted to 50.5 % of the total host trees. Nearly 37 % of these damaged trees were killed by the borer. The larger, dominant trees were more vulnerable to the infestation and mortality caused by the borer. Thus, tree diameter or growth rate was suggested to be an indicator of the favourability of each host tree as a food resource for the borer. The abundance of the borer in a host plantation was considered to be limited by the availability of favourable host trees.

INSECTS AFFECTING PINUS PINASTER REFORESTATION RELATED WITH SILVICULTURAL PRACTICES IN PORTUGAL

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In Portugal, the main insects affecting Pinus pinaster reforestation are the European pine shoot moth (Rhyacionia buoliana Schiff.), the pine weevil (Pissodes castaneus DeG.), and the weevils (Brachyderes lusitanicus F., and B. incanus L.).

In some young plantations, the number of trees damaged by R. buoliana is about 80%, and the number of trees with non-recoverable damage is more than 50%. The attacks are related with silvicultural practices. The attacks by P. castaneus are related with forest fires. This species is abundant when the reforestation follows the clearcuting burned areas. B. lusitanicus, and B. incanus can cause severe problems in young plantations when the site preparation removes the autochthon vegetation on the site. The most important damages are done by the adult insects that are forced to feed the shoots and leaves on the planted stock.

PREVALENCE OF AN ENTOMOPATHOGENIC FUNGUS, *HIRSUTELLA CITRIFORMIS* ON LEUCAENA PSYLLID, *HETEROPSYLLA CUBANA*, IN MALAYSIA. Ahmad Said Sajap and Mashita Mahmod, Department of Forest Management, Universiti Pertanian Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

The leucaena psyllid, *Heteropsylla cubana* Crawford (Homoptera: Psyllidae) is a serious pest of a multipurpose tree, *Leucaena leucocephala* (Lam.) (Leguminosae) in Southeast Asia, Pacific Islands, Hawaii and Australia. Even though the pest is already widespread throughout Malaysia, no information on the entomopathogens associated with this insect has been recorded. This study reports the prevalence of an entomopathogenic fungus, *Hirsutella citriformis* Speare (Deuteromycotina: Hyphomycetes) on the leucaena psyllid, *H. cubana* in Malaysia. Result from monthly sampling of the psyllid over a period of one year shows that the psyllid, was susceptible to infection by the fungus, *H. citriformis*. Dead psyllids were found mummified and cemented by cream coloured mycelia onto the leaves and branches of the leucaena plant. The result also shows that the adult psyllids were more prone to the fungal infection than those of the nymphs. The adult population had an infection rate ranged from 11 to 20% while the nymph had an infection rate of less than 2%.

MANAGEMENT AND CONTROL OF FOREST INSECT PESTS IN GERMANY. Bombosch,S. (Institute of Forest Zoology, University, Göttingen 3400, Germany)

For a long time two completely different strategies were employed in plant protection:
1. Cultivation of crops from the standpoint of the highest possible yield. Any difficulty arising from pathogens or phytophagous insects was overcome by the use of pesticides. This principle which came to be applied to agriculture throughout the world can no longer be sustained in its customary form for well-known reasons (provocation of outbreaks, resistance problems, ecological stress etc.).
2. Crops are cultivated from an ecological point of view. This principle, which has been followed since the beginning of forest management in Germany, has led to the intensive integration of natural forces into the measures carried out by man resulting, in most cases, in forest protection by means of natural self-regulation. Only in exceptional cases are additional measures necessary. The lecture aims at showing how it is possible that only ca. 2% of forest areas need to be treated per year whereas in agriculture every area is treated several times annually.

DIVERSITY OF WEEVILS (COLEOPTERA, CURCULIONIDAE) COMMUNITIES IN THE PINE FORESTS OF THE POLISH LOWLAND, LEAD UNDER DIFFERENT MANAGEMENT. Katarzyna Cholewicka-Wisniewska (Institute of Zoology, Polish Academy of Science, Warszawa 00-679, ul. Wilcza 64, Poland).

The research on the Curculionidae was carried out in 1986 and 1987 in two forest complexes: Puszecza Bialowieska and Bory Tucholskie. The studied forests were represented by two regional associations of pine forest: in Puszcza Bialowieska by Peucedano-Pinetum, and in Bory Tucholskie by Leucobrio-Pinetum.

This two forests lead under different management are distingushed in the way, and age of cutting. They are also differ in the species composition of plants.

Material was collected in three layers: canopies, herbs, and the soil surface. The material obtained consists of 2879 weevil individuals of 85 species. Intensification of forest exploitation results in decreasing abundance of individuals, decreasing diversity of species, and changes in the dominance structure.

PREDATORS AND PARASITOIDS IN THE MANAGEMENT AND CONTROL OF FOREST INSECT PESTS IN THE UNITED STATES. Donald L. Dahlsten (Division of Biological Control, University of California, Berkeley, CA 94706, USA).

When dealing with forest pest problems the importance of the higher trophic levels as regulators of pest populations is often overlooked. In North America most of the important forest insect pests are native species which have coevolved with their host trees and natural enemies. The influence of predators and parasitoids upon pest populations is an important aspect of natural control. Deliberate attempts to manipulate numbers and effectiveness of pest natural enemies is Biological Control. The utilization of imported natural enemies to control an exotic pest is termed Classical Biological Control and has been an effective technique in several pest situations. The introduction of imported natural enemies to control native pests is a concept called "New Associations". This strategy has been successful and may be of greater importance in the future. In addition, certain forest management techniques may be utilized which encourage natural enemy populations. Basic ecological studies of the forest ecosystem are necessary in order to utilize the ability of predators and parasites to control pest populations.

CURRENT USE AND FUTURE POTENTIAL OF PHEROMONES AND INSECT PATHOGENS IN THE MANAGEMENT OF FOREST INSECT PESTS IN THE UNITED STATES. Beckwith, R.C. and G.E. Daterman, USDA-Forest Serv., PNW Research Sta., Corvallis, OR, 97330, USA.

Use of pheromone methods or entomopathogenic sprays are the preferred agents for managing forest insects in the United States. This is due to the specificity of these agents, their low environmental hazard, and public acceptance. Pheromones are widely used in monitoring programs to delineate infestations, time seasonal activity, and increasingly, to assess population densities. Current use of pheromones for suppression is limited but the future is promising for managing defoliators, bark beetles, and regeneration and seed orchard pests. Pheromone app roaches include exclusion methods with antiaggregants, removal by trap-out, combined trap-out and exclusion, and the "mating-disruption" method to block communication between the sexes.

Among the microbial agents, Bacillus thuringiensis (BT) is widely used against forest defoliators. Biotechnological advances by transconjugal crosses and genetic engineering provide promise of more potent formulations of BT. Recently, the genetic component responsible for producing the BT toxin has been successfully transferred to the plant host genome, thus imparting the toxic properties to the host plant. Three nuclear polypolyhedrosis viruses are registered for use against forest defoliators; Gypchek for gypsy moth, TM BioControl-1 for Douglas-fir tussock moth, and Neo-Chek-S for the European pine sawfly. Research is underway to increase effectiveness and production of entomopathogenic viruses.

FOREST PEST MANAGEMENT IN THE UNITED KINGDOM
H.F. Evans[1], P.F. Entwistle[2], J.S. Cory[2] and C.J. Doyle[2]
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Non-chemical, environmentally benign, methods of control with nuclear polyhedrosis viruses (NPV's) have been developed for pine sawfly, *Neodiprion sertifer*, and pine beauty moth, *Panolis flammea*, the two major defoliators of *Pinus* spp. in the United Kingdom. As with the use of other pathogens, some insect feeding damage may occur during incubation of the virus in the target insect and, therefore, the damage threshold determining the need to apply the virus may be lower than for rapid—acting chemicals. However, an absolute pre—requisite in management of pests using either chemicals or pathogens, is establishment and implementation of an effective pest monitoring scheme with realistic damage thresholds. Infestations of *N. sertifer* and *P. flammea* may occur separately or jointly. Whilst the NPV diseases play a part in their natural population regulation, they tend not to prevent development of injurious infestations. Spray application of both NPV's has, therefore, been investigated extensively, concentrating on ultra low volume, controlled droplet applications with VMD in the range 80 - 100 m. Spray equipment has been developed specifically to address these requirements and is particularly appropriate to helicopter application over difficult terrain. *N. sertifer* NPV, commercially available as Virox ^{R}, is applied (ground or air) at 5 x 10^{9} polyhedral inclusion bodies (PIB's) ha^{-1} in 1.1 l ha^{-1}, a low dosage facilitated by the gregarious feeding behaviour of the larvae. The early feeding behaviour of *P. flammea* larvae within the bases of needles necessitates a higher PIB dosage (2 x 10^{11} ha^{-1}), more typical of NPV application against larval Lepidoptera, and a greater spray droplet density; a spray volume of 5 - 7 l ha^{-1} yielding about 1 x 10^{10} droplets ha^{-1} is adequate. *P. flammea* tends to attack larger trees, so aerial spraying is appropriate. For joint infestations, both *N. sertifer* and *P. flammea* NPV's can be applied together in a single spray at the higher volume rate. Partly because of effective NPV environmental persistence, control is effective for at least two years post-application.

MANAGEMENT AND CONTROL OF FOREST INSECT PESTS IN POLAND

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The forests in Poland covering about 8 million ha are mainly composed of Scots pine (more than 70%) and Norway spruce (7%). Frequent outbreaks of leafeating insects belonging to Lepidoptera and Hymenoptera are particulary dangerous for pure, even-aged stands.

The centre - complex method of biological forest protection is broadly implanted in practice as prophylactic organisation of forest enviromment resistance against pest insects.

Besides, every year some areas of forests are treated against insects with pyrethroids, benzoylphenyl ureas and Bacillus thuringiensis Berl.

EPIZOOTOLOGICAL PROBLEMS IN MICROBIAL FOREST INSECT PROTECTION. M. A. Golosova (Moscow Forest Technical Institute, Russia), M. A. Bottayev (Moscow Greenary Planting Departm. Russia)

At present epizootological direction in forest protection os cetting ever more significant. The analysis of epizooties in the 96 forest pest populations allowed to distinguish the main factors which are controlling infectious diseases in forest ecosystems. The development of epizooties depends first of all on biological peculiarities of the pathogens, on susceptibility to diseased and specific insect population's structure, on the sum of infection flows over different channels and on the balance between them and the environment. The realization of the epizootological direction of the pest control needs a deep study of all parts of the general infection chain of the pathogen.

INUNDATIVE RELEASES OF *TRICHOGRAMMA MINUTUM* AGAINST FOREST INSECT PESTS IN CANADA: 1982-PRESENT AND RECOMMENDATIONS. Sandy M. Smith (Faculty of Forestry, University of Toronto, Toronto, Ontario, Canada, M5S 3B3) and Don R. Wallace (Forestry Canada-Ontario Region, Great Lakes Forestry Centre, P.O. Box 490, Sault Ste. Marie, Ontario, Canada, P6A 5M7).

The manipulation of insect parasitoids for the control of forest insect pests has been conducted in Canada since the early 1900's. In most cases, this has meant the release of exotic parasitoids against specific pests, either introduced or native, to reestablish known parasitoid/host associations or to form new ones. In forestry over the past 10 years, interest in using native parasitoids for biological control of native pests has increased because of the public's desire for reduced use of chemical pesticides. This has meant finding ways to improve the impact of native parasitoids on forest insect pests, one of which is inundative release.

Field trials during the 1980's, in Ontario using releases of the egg parasitoid, *Trichogramma minutum*, against the spruce budworm suggest that inundative release could prove to be a useful tool for biological control in forestry. This approach entails collecting native parasitoids from their natural hosts and environment, bringing them to the laboratory or a commercial rearing facility to augment their numbers, and then returning them to the field at the appropriate time for pest suppression. With a sound information base, it can provide a feasible alternative to conventional insecticides in environmentally sensitive areas. The present paper will discuss the historical development of *Trichogramma* for use against the spruce budworm in Canada and provide recommendations for the application and future research in the advancement and commercialization of this strategy.

FOREST INSECT PEST MANAGEMENT IN ZIMBABWE. Ramas Mazodze (Forestry Commission, Forest Research Centre, Box HG 595, Hishlands, Harare, Zimbabwe)

Major insect pest problems in Zimbabwe are on exotic trees (mainly *Eucalyptus*, *Pinus* and *Cupressus*) which are commercially important and are grown in plantations. Termites are especially a problem in eucalypts and aphids are important on the other two genera. Indigenous trees, except for a few cases, are generally free from serious pest attack.

The paper presents the present pest management tactics employed against the major forest insect pest encountered in Zimbabwe. An Integrated Pest Management (IPM) approach is emphasized.

MANAGEMENT AND CONTROL OF FOREST INSECT PESTS IN BULGARIA. Georgi Tsankov, Plamen Mirchev, and Georgi Georgiev (Forest Research Institute, Sofia, Bulgaria.

There are 3.7 million ha of forests in Bulgaria, and 32.2 % of these are coniferous. Mass insect pests are Lymantria dispar L., Malacosoma neustria L., Euproctis chrisorrhoea L., Tortrix viridana L., Operopthera brumata L., Hibernia defoliaria L., Stilpnotia salicis L., and others, and of the coniferous forests - Thaumatopoea pityocampa Schiff., Neodiprion sertifer Geoffr., Diprion pini L., Acantholyda erithrocephala L., and others. Periodically, after each 10-11 years, gradations of L.dispar and other leaf- and-needle-gnawing insects, have been observed. The mass application of bacterial preparations based on Bacillus thuringiensis helps for decreasing the attacked areas.

In Bulgaria, after 1974, the areas of forest biocoenoses treated with pesticides started decreasing gradually, on account of those where biological control of pests was applied.

INTEGRATED MANAGEMENT AND CONTROL OF THE GYPSY MOTH IN THE UNITED STATES. Richard Reardon (USDA Forest Service, Morgantown, WV, USA)

The USDA Forest Service was directed to initiate an integrated pest management special project, Appalachian Gypsy Moth IPM (AIPM) Project, to minimize the spread and adverse effects of the gypsy moth, Lymantria dispar L. The overall five-year (1988-1992) objectives of the Project are to: 1) minimize the spread and adverse effects of the gypsy moth within the Project area; 2) develop a general prototype IPM structure; 3) evaluate the use of intervention activities for the management of isolated infestations; and 4) assess the feasibility of a coordinated County, State, and Federal gypsy moth program.

INTEGRATED MANAGEMENT OF THE PINE WOOD NEMATODE AND THE PINE SWAYER, CAUSING HEAVY INFESTATION OF PINES IN JAPAN AND NEIGHBORING COUNTRIES. Akiomi Yamane (Faculty of Agriculture,University of Tokyo,Bunkyou-ku, Tokyo, 113 Japan), Akihiko Taketani (Forestry and Forest Products Research Institute, Tsukuba, 305 Japan)

Mortalities of Pinus thunbergii and P.densiflora have been occurring for decades mainly in southwestern parts of Japan, now spreading to more northern parts.. Since the detection of causal agent in 1970, the wood nematode, Bursaphelenchus xylophilus (Nematoda:Aphelenchoidae), and its vector, the Japanese pine sawyer, Monochamus alternus (Coleoptera:Cerambycidae),various new and traditional managing measures have been developed and improved for protection of pines for about two decades.The traditional cut-and-burn, or cut-and-spray are widely applied, however, thorough control were difficult to achieve . On the other hand new preventive methods have been developed,preventive spray for stopping adult sawyers' feeding, and another is trunk injection of nematocide for control nematode invaded into standing pine.

Effectiveness of those control measures will be evaluated and at the same time, the difficulties recruiting labors and providing costs for managements due to the socio-economical changes will be reviewed.

INTEGRATED MANAGEMENT OF THE LEAF BEETLE, CHRYSOPHTHARTA BIMACULATA, (OLIVIER) (COLEOPTERA: CHRYSOMELIDAE) IN EUCALYPT PLANTATIONS IN TASMANIA

Humphrey J. Elliott, Forestry Commission, Tasmania
G.P.O. Box 207 B, Hobart 7001, Tasmania, Australia

The leaf beetle, Chrysophtharta bimaculata, is the major defoliator of eucalypt plantations in Tasmania causing economically significant growth losses in the major commercial eucalypt species.

A control strategy has been developed which allows heavy natural predation of eggs and early instar larvae by coccinellid and cantharid beetles. If regular monitoring of developing populations of leaf beetles indicates that defoliation will exceed an economic threshold level (by reference to a predictive model of the effects of defoliation on growth) insecticides are applied before significant defoliation occurs.

Synthetic pyrethroid insecticides or the biotic insecticide, Bacillus thuringiensis var. tenebrionis are applied to high leaf beetle populations depending on synchrony of population stages and operational factors.

MACADAMIA QUICK DECLINE AND ITS CONTROL. Vincent Chang (Hawaiian Sugar Planters' Association, P.O. Box 1057, Aiea, Hawaii 96701, USA)

Macadamia nut production is a $45 million business, the third largest agricultural activity in Hawaii. Before 1985, the industry had few insect and disease problems threatening the industry. However, in summer of 1986, many mature trees died suddenly of unknown causes. The problem was named the macadamia quick decline (MQD).

Many females of *Xyleborus perforans* were collected from the openings of bored holes on tree trunks having MQD symptoms. *X. perforans* was found capable of attacking symptomless, live mature trees. The beetle successfully bored into 65% of the trees tested. Cultivars 294 and 660 were less attacked by the beetle than other cultivars. A parasitic wasp was found attacking the adult of *X. perforans*. White funnel traps with 95% ethyl alcohol as an attractant caught more *X. perforans* than other types of traps. The same type of funnel traps which were black instead of white caught mostly *Xyleborinus saxeseni*. We observed that the peak beetle population in the orchard occurred in October. The population level could be reduced by sanitation, trapping, the use of resistant cultivars, and the application of an insecticide (endosulfan).

ADAPTATION OF CYTOPLASMIC POLYHEDROSIS VIRUSES (CPV) TO THE SPRUCE BUDWORM *CHORISTONEURA FUMIFERANA* (CLEMENS). Serge Belloncik, F. Kendirgy, R. Athanassious (Institut Armand Frappier, Université du Québec, Laval, Canada), Liang Tao, Changjie Chen, Zhixian Wang and Jiawen Chen (Institute of Forestry Beijing, China)

The spruce budworm *Choristoneura fumiferana* (Clemens) is a major insect pest of the forests in Canada, mainly in Ontario, Québec and New Brunswick. Therefore, the evaluation and the development of biological agents for the long term control of this insect are justified.
The CPV was the less studied, among the pathogens of the spruce budworm, despite the fact that its efficacy in combination with the NPV was noted in Ontario. The CPV's present however some interesting characteristics which can justify their use in stable ecosystems as the forests.
Investigations on the infectivity and on the effects on the spruce budworm of *Choristoneura fumiferana* and *Dendrolimus* CPV's were conducted in the laboratory. Light and electron microscopy and viral RNA gel electrophoresis techniques were used to monitor and to characterize the viral replication following infection of the larvae with the CPV's. The susceptibility of the spruce budworm for the two CPV types was demonstrated. Moreover dual infection was recorded. Further results obtained in relation of the induction by a stress of the CPV in a population of the spruce budworm will be discussed in this presentation.

ACHILLES' HEELS FOR METALS IN THE BOREAL FOREST ECOSYSTEM

Pekka Nuorteva

(Department of Environmental Conservation, University of Helsinki, SF-00710 Helsinki, Finland)

Taller chimneys and longer waste pipelines have during recent years diminished pollution at point sources but increased pollution at extensive background areas. These are getting pollution simultaneously from different sources and are damaged when the multistress pressure grows over the tolerance limit. In order to study the degree of danger in this kind of multistress situation our study group by the Department of Environmental Conservation of Helsinki University found it most essential to search up from the biocoenoses such Achilles' heels, where the pollutants reach the highest levels. The next step, has been to determine whether the observed accumulations are high enough to cause real harm to the target organisms or their predators. When we studied Cd and other metals in boreal forest ecosystem we could not find regular bioaccumulation, but detached accumulations in 1) detritus and detrivores (including mushrooms), 2) in the phloem of coniferous trees, 3) in Formica-ants, eating honeydew produced by phloem feeding aphids, 4) in phloem feeding bark beetles and 5) in spiders. By feeding we elevated the Cd-contents of Finnish ants to a level occurring in industrialized Central Europe. As damage criterium we used the capacity of the ant colony to regulate the temperature of the nest, but we found no effect. For spiders we noted that the high metal content of spiders is not determined by the flow from the food but, but by formation and delayed excretion of inactive metal granulae in hepatopanchreas (as reported by Ludvig & Alberti 1988). Ants and spiders are thus quite resistant against metals. At the present it is unknown whether also their predators are resistant. We have noted that the ratio Cd/Zn is not changing during transfer from soil to plants, but changes during the transfer to the herbivores. Because Zn has a toxicity stabilizing effect on Cd, pathogeny may develop during the plant/herbivore transfer.

AIR POLLUTION AND FOREST INSECTS. Joachim Schönherr (Institute of Forest Zoology, Albert-Ludwigs-University, Freiburg 7800, Germany)

The lecture gives a review of historical development of the air pollution in Europe since last century. It is demonstrated that air pollution has changed from easily recognizable smoke damage of trees near certain pollutant sources to a global problem threatening the forests in all of Europe. The state of knowledge and perspectives are discussed.

HOST PLANTS OF THE WORLD CHRYSOMELIDAE (COLEOPTERA). Pierre Jolivet (67 Bd Soult 75012 PARIS, France)

The Chrysomelidae, a large family of Coleoptera with more than 37,000 described species, is second only to Curculionidae on the estimated number of world species. The leaf beetles have a catholic taste and may feed on grasses, herbaceous plants, shrubs and trees. The adults of many Alticinae feed in the canopy of the tropical forests together with the Megascelinae, Eumolpinae, and Galerucinae in the Neotropics. Apparently food choice is linked to flight ability, the trees in such forests being defoliated by active flyers. However, the Colorado potato beetle, a good flyer with high dispersal capabilities feeds exclusively on low herbaceous plants, several tender species of Solanaceae, especially *Solanum*. There is an exception to every rule and flying ability is not the only criterion for colonization. The food plants selected can vary widely between different vary widely between different chrysomlid subfamilies. They mostly select Angiosperms but two subfamilies prefer Monocotyledons. Gymnosperms, ferns, horsetails, mosses, and even fungi are sometimes selected but they are generally secondary adaptations. Most leaf beetles are oligophagous and very few are truly polyphagous. Their larvae have extremely diverse feeding habits from external foliage feeders, pollen and flower eaters., miners, gall-makers, stem-feeders, fruit eaters, myrmecophiles, and detriticoles (casebearers).

FOREST PESTS AND THEIR MANAGEMENT IN INDIA.
P.K. Sen-Sarma (Presidency College, Calcutta, India)

Forest insect pests in India cause a loss of at least 15% of the produce and include defoliators, xylophagus insects, shoot borers, canker causing insects, gall formers, sap-suckers, pests of flowers, seeds and fruits and wood-destroying insects. Current efforts on reforestation and afforestation inside and outside reserved forest areas especially with exotic tree species has resulted in newer pest problems/pest resurgence. In a few cases, unimportant pests have attained key-pest status. Forest entomologists are also now required to tackle pest problems in urban recreation forests, rural community forests, water-shed forests in addition to pests in reserved forests. Pest management strategies include cultural, sylvicultural cum biological, microbial, behavioral, chemical and IPM. These have been discussed.

ECOLOGICAL PROBLEMS OF THE JAPANESE PINE SAWYER, AS THE VECTOR OF PINE WOOD NEMATODE CAUSING HEAVY MORTALITY OF PINES. Akiomi Yamane (Faculty of Agriculture, University of Tokyo, Bunkyou-ku, Tokyo, 113 Japan), Nobuo Enda (Forestry and Forest Products Research Institute, Tsukuba, 305 Japan)

The Japanese pine sawyer, Monochamus alternus (Coleoptera: Cerambycidae), is one of the most destructive forest insects in Japan, and possibly in the neighbor countries, because it plays a role in transportation of the pine wood nematode, Bursaphelenchus xylophilus (Nematoda:Aphelenchoidae), which is severely pathogenic to pines, Pinus thunbergii, P. densiflora, and other endemic pine spp. in Japan.

Generally sawyers are known as secondary insect and does not kill trees. In fact the sawyer adult attacks only dying pines for oviposition. However, the adult feeds on bark of tender twig of healthy standing pine after emergence for survival and maturation. The feeding itself often results in the death of the twigs fed, but not the whole tree. This means the sawyer is primary insect to pines and at the same time not so dangerous. This has not been true since the pine wood nematode alternated with the endemic wood nematode, B.mucronatus.

Biology of the beetle is well elucidated, which does not meen complete control of pine mortality due to its ecological nature and dispersal behavior, of which problems will be presented and discussed.

The Eucalyptus Borer Phoracantha semipunctata Fa.-Ecological factors contributing to its pest status
M. Rosa Paiva
New University of Lisbon/FCT, 2825 Mte. Caparica, Portugal

The cerambycid P. semipunctata originates from Australasia, being now distributed through most eucalyptus growing regions of the world, often causing economic losses to timber producers Little damage however occurs in Australia, multiple ecological factors contributing to this situation. Monocultural plantations take up an insignificant area in the australian continent, while natural forests contain a mixture of local eucalypt species, some of which although atractive to oviposition by P. semipunctata, will not enable the completion of the borer's life cycle. On the contrary, most of the eucalyptus producing countries, like Portugal, cultivate over vast areas of low biodiversity, a few species only. In Australia a rich and abundant natural enemie species complex exists, which is generaly reduced elsewhere. Life tables built for P. semipunctata in different regions of the world, allow for comparisions of the incidence and relative importance of the different mortality factors and for the extrapolation of some conclusions.

MOUNTAIN BIRCH FORESTS: VARIABLE RESOURCES FOR HERBIVOROUS INSECTS. Kai Ruohomäki, Sinikka Hanhimäki, Janne Suomela (University of Turku, Department of Biology, Laboratory of Ecological Zoology, SF-20500 Turku, Finland)

Suitability of different plant species to herbivores is determined by species-specific properties of herbivores and factors causing variability in plant quality. Annual, seasonal and spatial variation in foliage quality may all be dependent or independent of herbivore density. Spatial variation occurs at different levels, for example among forests, among trees within forests and among parts of individual trees. Also, quality differences among plant species may sometimes depend on herbivore density; herbivore-induced responses in plants may change host plant ranking. Besides practical problems in executing biotests, variation in foliage quality has ecological and evolutionary consequences for herbivores and their host plants.

DISTRIBUTION PATTERN OF TWO MAJOR PESTS OF *AILANTHUS TRIPHYSA* IN FOREST PLANTATIONS. R. V. Varma, (Division of Entomology, Kerala Forest Research Institute, Peechi - 680 653, Kerala, India)

The spatial and temporal distribution of two major pests of *Ailanthus triphysa* viz. *Atteva fabriciella* (Yponomeutidae: Lepidoptera) and *Eligma narcissus* (Noctuidae: Lepidoptera) have been studied in a 10 ha plantation over a period of three years. The larval population of both the pests was monitored in 18 transects, covering the entire plantation, at regular intervals.

Both the pests followed a clustered pattern of distribution, over space and time which was also influenced by both biotic and abiotic factors in the locality. Incidence of *A. fabriciella* was negatively correlated with rainfall, but incidence of *E. narcissus* had no such correlation.

PREDICTING FOREST INSECT OUTBREAKS USING GEOSTATISTICAL MODELS

ANDREW LIEBHOLD, *USDA Forest Service, Northeastern Forest Experiment Station, P.O. Box 4360, Morgantown, WV 26505;* MICHAEL HOHN, *West Virginia Geological & Economic Survey, P.O. Box 879, Morgantown, WV 26506;* GREGORY ELMES, *Dept. of Geology & Geography, West Virginia University, Morgantown, WV 26505*

Outbreaks of forest defoliators often occur over very large areas but are notoriously difficult to predict. Previous models developed for predicting outbreaks have relied on data collected at a single point and have largely ignored spatial processes. We have adapted a geostatistical modeling approach, originally developed for geological applications, to the problem of forecasting gypsy moth defoliation distribution. Specifically we are using 3-dimensional simple kriging to extrapolate future defoliation maps from historical patterns. The technique also incorporates a variety of landscape and census data to fine-tune expected outbreak probabilities. These models form an integral part of new forest pest management programs that rely on geographical information systems for the management and manipulation of numerous spatially-referenced data layers. Application of this modeling approach is illustrated for the gypsy moth, *Lymantria dispar*, and the *spruce budworm, Choristoneura fumiferana.*

MECHANISMS OF GENETIC RESISTANCE IN WOODY PLANTS TO FOREST INSECTS. Yiqun Lin, Mike Wagner
(School of Forestry, Northern Arizona University, Flagstaff, AZ 86011, USA).

During the past several decades we have seen an increasing amount of literature regarding woody plant resistance to forest insects and diseases. A thorough discussion of the mechanisms of genetic resistance in woody plants, however, is generally lacking. Therefore, we summarize the available literature on genetic resistance and classify plant resistance according to mechanism type. Based on our review, most of the mechanisms of genetic resistance are related to chemical factors. In contrast to this, our previous research has shown that both physical structure and chemical factors of needles may play a role in the resistance mechanism of ponderosa pine to Neodiprion sawflies of the southwestern United States. We present our data of the heritability of these mechanisms in half-sib and full-sib family seedlings. Finally, we discuss existing problems in current research on genetic resistance mechanisms of woody plants and prospects for future tree breeding programs.

CONIFER SEED LOSSES TO LEPTOGLOSSUS OCCIDENTALIS IN NORTHWESTERN NORTH AMERICA. T.D. Schowalter (Entomology Department, Oregon State University, Corvallis, OR 97331-2907 USA)

The seed bug, Leptoglossus occidentalis (Hemiptera: Coreidae) feeds on seeds of conifers and other trees in western North America, but effects on seed production in conifer seed orchards have been examined only recently. Monitoring of L. occidentalis populations and feeding activity is hampered by the apparent migratory behavior of this insect. Studies of Pinus and Pseudotsuga cones caged with or without L. occidentalis indicated that effects of feeding vary during the period of cone development. Feeding early during cone development causes cone abortion and significant reduction in number of mature seed/cone. Feeding on mature cones causes significant loss as partially-eaten seeds. Current radiography techniques for evaluating seed condition can be used to detect partially-eaten seeds, but cone and seed abortion as a result of L. occidentalis feeding early in the cone development process may be ascribed to other factors causing these symptoms, resulting in under-estimation of seed losses to L. occidentalis. New techniques are necessary to assess the extent of this feeding injury in conifer seed orchards.

USE OF CONE AND SEED INSECT PHEROMONES IN SEED ORCHARDS: PROBLEMS AND PROGRESS. G.L. DeBarr (Southeastern Forest Experiment Station, USDA Forest Service, Athens, Georgia, 30602 USA).

Forest tree seed orchards are managed for maximum production of genetically improved seed. Seed orchards have unique characteristics and present interesting opportunities to employ sex pheromones and other behavior chemicals in insect monitoring and control activities. Efforts to identify sex pheromones to which coneworms (Dioryctria spp.), seedworms (Cydia spp.), seed moths (Eucosma spp.) and cone beetles (Conophthorus spp.) respond are summarized. Some limitations on the use of semiochemicals as pest management tools in forest tree seed orchards are discussed. Progress on the use of synthetic sex pheromones to monitor and control these insects are discussed.

OLFACTORY SENSITIVITY OF ADULTS MEGASTIGMUS SPERMOTROPHUS TO HOST AND NON-HOST PLANT ODORS. Frédéric MARION-POLL, Denis THIERY (Laboratoire de Neurobiologie Comparée des Invertébrés, INRA-CNRS, BP 23, 91440 Bures-sur-Yvette, FR)

Douglas-fir seed chalcid females *(Megastigmus spermotrophus)* are selectively attracted to cones for oviposition. Comparisons of chemical profiles of volatiles emitted by douglas-fir and larch (A. Roques, INRA Orléans, FR) have demonstrated that the blends differ both qualitatively and quantitatively.

We have evaluated the olfactory sensitivity of douglas-fir seed chalcid adults to terpens and generally occuring plant volatiles. No specific olfactory sensitivity (as tested with the electroantennogram method) was found to compounds identified from douglas-fir cones. Instead, adults of both sexes displayed a wide sensitivity to general occuring monoterpens and hydrogenated carbohydrates found in flowers and plant leaves. The high sensitivity to floral odors might be related to nectar-feeding activities. A sexual dimorphism was found in response to some of these compounds. Other parameters of the EAG response were tested. The half recovery time of the response was significantly higher in response to 8 compounds which might indicate a higher behavioral activity.

Further electrophysiological tests (EAG and single cell recordings) with headspace extract from cone volatiles are needed to confirm if some receptors are tuned to minor compounds not yet identified. Although olfactory receptors of specialists insects are generally tuned to host-plant specific volatiles, some oligophagous insects (e.g. the Colorado potato beetle) use general volatiles and orient towards a specific blend ratio of these compounds.

A STUDY ON CLEARWING MOTH ON CHESTNUT TREES. Hui-Ying Liu, Zhou Qingjiu(Department of Forestry, Hebei Forestery College, Baoding, 071000, China)

Investigation shows that 2 kind of clearwing moth harming chestnat trees, Sywanthedon castanevora Yang et wang and Sesia molybdoceps Hampson, are found in Hebei province. The former is distributed mainly in the chestnut-producing counties in Hebei and Beijing Municipality, and is more harmful than the other. But the latter one is observed randomly. Synanthedon catanevora propagates two generations per year. It overwinter in larval stage, and emergence of the adults concentrates in the 2nd and 3rd decades of May. The incubation of the larvae starts in latter May and early June. For the adults of the 1st generation, from early to mid August is their peak period of emergence. The larvae of the 2nd generation start to incubate in the 2nd decade of August. The following can be used to control the insects:scraping scars in early spring; painting the scars with omethoate EC and methamidophos EC after autumn; scraping eggs together with spraying sumicidinEC and phoxim EC over the trees when they lay eggs. These can reduce the mortality of trees from 0.1% to 0.01%.

STEM INJECTION OF DIMETHOATE FOR CONTROL OF EUROPEAN LARCH (*LARIX DECIDUA* MILL) CONE AND SEED INSECTS. Nicolai Olenici (Experiment Station for Spruce Culture, 5950 Cimpulung Moldovenesc, Romania)

The systemic insecticide dimethoate was injected into European larch trees to determine its efficacy in controlling cone and seed insects. Percentages of cones and seeds damaged by insects and the germination of the seeds were assessed. The treatments were more effective against the larvae of *Strobilomyia* sp. and *Retinia perangustana* Snellen, and less effective against those of *Resseliella skuhravyorum* Skrzypcz., and they did not reduce the percentage of germinated seeds.

PSYLLID INVADING SAXAUL TREE IN IRAN ,Ebrahim Adeli,University of Tehran,College of Natural Resources ,Karaj -Iran.

This insect is an important pest of saxaul in Iran. Its directly feeding on leaves and making galls causes a severe damage on Haloxylon plantations.According to the research carried out on this plant in Iran during 1989-1991,now it is quit clear that this psyllid has 3 generations anually and third nymph instars.

In spring of the subsequent year,the nymph feed on yong twigs and make a number of galls amongst the branches. Their eggs are white ,with pear shaped. Eggs are laid on intervals of young shoot joints,around the axis of t igs so that distal ends of them are merely visible .The maximum of 20 eggs are laid on each joint space and they hatch after 7 days . Nymph start to feed and to make galls immediately.

INFLUENCE OF PHENOLIC GLYCOSIDES IN THE RESISTANCE OF LEUCE POPLARS CLONES TO *CHRYSOMELA TREMULAE* (COLEOPTERA, CHRYSOMELIDAE)

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The relationship between the food selection of *Chrysomela tremulae* and the phenolic glycosides of Leuce poplars clones was investigated. Presence and composition of phenolic compounds was studied in 6 clones.
The four phenolic glycosides, salicortin, tremulacin, tremuloidin and salicin occured in all clones analysed but level of salicin and tremuloidine were low in everyone. Concentrations of these substances varied among clones.
Feeding bioassays using filter paper discs showed that salicortine is the main phagostimulant for *C. tremulae* while tremulacin and tremuloidin will act as feeding inibitor

FACTORS INFLUENCING HOST TREE SELECTION AND FEEDING BEHAVIOUR BY THE EUCALYPT LEAF BEETLE *CHRYSOPHTHARTA BIMACULATA* (OLIVIER).

J.L. Madden (Department of Agricultural Science, University of Tasmania, GPO Box 252C, Hobart, Tasmania, Australia, 7001.)

Chrysophtharta bimaculata (OLIVIER) causes significant defoliation which hinders plantation establishment and causes increment loss in commercially important timber and pulpwood eucalypt species in Tasmania.

Adult beetles emerge from hibernation and reproductive diapause to seek new hosts. Studies indicate that location of single trees and tree patches is affected by foliage colour (reflectance) and significant catch of beetles are recorded on green-yellow sticky traps. Acceptance/rejection of foliage for oviposition is mediated through the response of female beetles to leaf chemicals, notably monoterpenes, which in turn may affect subsequent larval survival and development.

The susceptibility of individual trees to attack is influenced by its phenology which determines the rate of foliage colour change and duration of attractiveness. Beetle attack results in the development of two groups of trees which differ in growth form and susceptibility to attack. Such events contribute to an efficient strategy of host tree exploitation.

A FIELD EXPERIMENT ON DISPERSAL OF NEWLY EMERGED ADULTS OF *MONOCHAMUS ALTERNATUS* (COLEOPTERA: CERAMBYCIDAE).

Katsumi Togashi (Faculty of Integrated Arts and Seiences, Hiroshima Univ., Hiroshima 730, Japan)

Adults of *Monochamus alternatus* are known as the primary veetor of pine wilt whieh has heavily damaged young and old forests of *Pinus thunbergii* and *P. densiflora* in Japan. Newly-emerged adults aged 1 to 5 days were marked and released by placing them on the trunks of one or two trees in a *P. thunbergii* stand at weekly intervals during the beetle emergence periods for four years. Beetles were eaptured at weekly intervals. When the stand eanopy was elosed, the rate of beetle's stay on a tree was 0.56 per week. The beetles dispersed at random by walk and flight. When the pine stand was sparse, the rate of beetle's stay on a tree was 0.02-0.30 per week. They dispersed at random by flight. The average distanees traversed were estimated to be 7.1-37.8 m for the first week after emergenee. The results of stepwise multiple regression analysis suggested that the dispersal of newly-emerged beetles was affeeted by stand density, maximum air temperature, and precipitation.

The average beetle density in a pine stand is positively eorrelated to the incidenee of pine wilt. As the insect reproduces in trees killed from pine wilt, high beetle densities would inerease the density of newly-emerged beetles of the following generation, but a redueed density of healthy trees would aeeelerate the dispersal of newly-emerged beetles, resulting in the decrease of average beetle density in a stand. This suggests a eomplieated process in the yearly change of pine wilt ineidenee.

OCCURRENCE, LIFE HISTORY, AND MANAGEMENT OF PEAR THRIPS IN SUGAR MAPLE STANDS IN PENNSYLVANIA. E. Alan Cameron, D. A. J. Teulon (Dept. of Entomology), L. H. McCormick, and T. E. Kolb (School of Forest Resources, Penn State University, University Park, PA 16802, USA)

Taeniothrips inconsequens (Uzel) (Thysanoptera: Thripidae) , has damaged Acer saccharum (Marsh.) stands in Pennsylvania and other northeastern United States in recent years. The insect is univoltine, living as larvae, pupae, and adults from May through March in the soil. In the spring, at approximately the time leaf buds swell and leaves expand, adult thrips emerge from the soil, move to tree crowns, feed, and oviposit. Larvae feed, molt once, complete leaf feeding, and drop to the ground.

Development of management tactics and strategies must take into consideration the phenological synchrony of the insect and its host. Use of chemical pesticides may create unacceptable residues in a food crop (maple sap/syrup). If appropriate exotic parasites can be identified, cultured, released, and established, biological control may be possible. Predators do not appear promising; most potential predators are polyphagous. Pathogens, especially fungi, may cause mortality during the time thrips are in the soil; exploitation of fungi will present major challenges. Implementation of controls will be difficult, and any use ultimately will depend on economics.

EFFECT OF TROPICAL RAIN FOREST CLEAR-CUTTING ON DUNG BEETLES (COLEOPTERA: SCARABAEINAE). THE SCARABAEINAE AS PARAMETER FOR THE ANALYSIS OF RAIN FOREST DIVERSITY. G. Halffter, M.E. Favila and V. Halffter. Instituto de Ecología, Apartado Postal 63, Km. 2.5 Antigua Carretera a Coatepec 91000 Xalapa, Ver. México.

Since 1964 dung beetles have been sampled in various tropical rain forest in Southern México. With this information we analyzed the long and short term effect of rain forest clear-cutting on the Scarabaeinae guild. Three rain forests were analyzed: Boça de Chajul, Palenque in Chiapas, and Los Tuxtlas in Veracruz. The guild of dung beetles has a similar structure in these forests: there are between 23 to 27 species; non rolling beetles dominate over rolling-beetles; generalist species predominate over necrophagous and coprophagous species; nocturnal are more abundant than diurnal species. Dung beetles in Palenque were also sampled in an edge, and in a recent clear-cut. Twenty seven species were collected within the forest, 11 on the edge, and 5 in the cut zone. In a pasture, that was a rain forest before, near Laguna Verde, Veracruz, the dung beetle guild have 18 species with only 4 species of the original forest; diurnal species predominate over nocturnal species and coprophagous are more abundant than generalist species.

Results suggest that the clear-cutting of the tropical rain forest in the short term affects mostly the species that live within the forest, the species that live in the edge have greater possibility of the adaptation in the clear-cut areas

THE SURVEY AND TAXONOMY OF CHALCIDS PARASITIZING BARK BEETLES IN CHINA (HYMENOPTERA:CHALCIDOIDEA). Yang Zhong-qi (Department of Forest Prostection, Northwestern College of Forestry, Yangling, Shaanxi Province 712100, China)

Based upon studies of over 20 thousand chalcid specimens collected and reared from many parts of China, the present paper describes 37 genera and 99 species of chalcids parasitizing bark beetles belonging to four families of Chalcidoidea (Hymenoptera), in which five genera and 80 species are new to science, and 19 genera and 13 species new to China.

Meanwhile, a historical review on the subject in a global scale, the morphology and biology of chalcids are also dealt with. In the taxonomic part, each family contains a short genus definition, main literature cited, key to species, if it has more than one species, and species description. At last, the phylogeny of *Roptrocerus* Ratzeburg, 1844 (Pteromalidae) is studied.

FAUNA ANALYSIS OF TIBET FOREST INSECTS. Shulin Li, Xutang Liu (Forestry Expedition and Research Institute of Tibet, Lhasa 850000, China), Gangxi Zhang (Plant Protection Station of Tibet, Lhasa 850000, China)

Tibet plateau is a special insect geographical unit. Together with the land rising, correspondingly plateau geography, climate, vegetation changed. The change makes the forest plants and their parasites having their unique features which are different from other regions in distribution, species compositions, morphology, biology, and adaptation. 365 species of forest insects are recorded, and according to the integrated analysis, Tibet plateau forest insects are divided into 5 subregions and 14 districts

I. South Himalayas warm and humid needle, broad leaf mixed forest subregion, including 3 districts.

II. Middle and lower reach of Yaluzhangbu river temperate, semi-humid needle leaf forest subregion, incuding 3 districts.

III. Mt.Hengduan arid-hot semi-humid spot dark needle leaf forest subregion, including 2 districts.

IV. Mid-south Tibet semi-arid and cool bushreld psilium less forest subregion, including 4 districts

V. North Tibet cold bushreld-eremean subregion, including 2 districts.

Some main insect pests and their management are also reported in the paper.

A STUDY ON INTEGRATED CONTROL OF POPLAR PESTS HEADED BY ANOPLOPHORA GLABIPENNIS MOTSCH. IN NORTH CHINA. Jing-fang Huang, You-qing Luo, Shu-chun Chen (Beijing Forestry University, Beijing 100083, China) Jun-lou Zhang Xing Sun Li-jing Dong (Beijing Forestry Protection Staiton)

Sect. Leuce poplar and Sect. Aigeiros poplar which extensively planted in North China are demaged by many pests, particularly by Anoplophora glabripennis. Research results show: linear regression of primary spread of A. glabripennis from pest-source tree to non-infestated stand: Ylarva=0.4176-0. 0014x correlation coefficient r=-0. 6799. Ylarva-density of A. glabripennis larva per tree. X(m)-distance from pest-source tree to the tree. Primary spread of A. glabripennis is always within 300m in poplar stretch. Strict quarantining sampling against Parathrene tabaniformis, Saperda populnea; Spraying twicely 2500×deltamethrin to A. glabripennis source-tree in middle later decade of June and middle later decade of July, protecting, and attracting woodpecker: Spraying pesticide to leaf pests e. g. Clostera anachoreta or plucking their egg-mass in first stage of occurance, can effectually control the main poplar pests for aim of integrated control.

THE PREFERENCE OF A CERTAIN LEAF SIZE BY FOLIVOROUS INSECTS: PROBLEM CREATED BY RANDOM SAMPLING. Bogacheva I.A. (Institute of Plant & Animal Ecology, Ekaterinburg 8 March Street 202, 620219 USSR)

Using random sampling as simple method to collect leaves in a tree crown we found in weevil Polydrusus ruficornis feeding on Betula pubescens ssp. tortuosa a strong preference to small leaves. Leaf-beetle Gonioctena pallidus feeding on Salix phylicifolia was shown to prefer large leaves.Both these species tend to feed on young top leaves of long shoots,but birch has the smallest leaves in distal part of long shoot while willow has the largest ones.Non-random distribution of large and small leaves in different parts of shoots and of tree crown and insect preference to leaves in certain parts of shoots and of tree crown create the effect of choosing of a certain leaf size by folivorous insects. This effect would disappear when we refuse from random sampling.

REPRODUCTIVE SUCCESS, BODY SIZE, AND PHEROMONE CONTENT IN BARK BEETLES

Schlyter, Fredrik
Pheromone Group, Dept. Ecology, Lund University, Ecology Building, S-223 62 LUND, SWEDEN.

Bark beetles (Coleoptera: Scolytidae) form long-lasting pairs or harems in galleries in the host plant. Apart from quantity and quality of the host material, the partner quality (and the number of females in polygynous sp.) is an important factor in reproductive success of an individual.

Present knowledge indicate that mate choice may take place based on two types of characters; those related to body size and to pheromone communication.
In the present contribution I will present evidence that:

1) Mate choice takes place, based on a pattern of positive assortative mating for body size (following Crespi [1989, Anim. Beh. 38:980-1000]) in *Tomicus minor* and *T. piniperda*.
2) Body size shows a small but significant heritability in *Ips typographus*.
3) As expected from 2), selection for size is possible in the laboratory for *Ips*.
4) In *I. typographus*, a polygynous sp., there is little assortative mating by body size and male body size does not influence harem size. Whether males with the largest number of females have a larger pheromone content is currently investigated.

SEMIOCHEMICAL MEDIATED ATTRACTION IN THE SMALL BANDED PINE WEEVIL Pissodes castaneus (Col., Curculionidae). Pajares Juan A. (Dptment, Forest Systems, CIT-INIA; Madrid, 28040, Spain), A. Guerrrero (Dptment. Organic and Biological Chemistry, CSIC, Barcelona 08034, Spain).

The small banded pine weevil Pissodes castaneus (=notatus) is an important pest of pines in Europe; After a post-emergence maturation feeding, the females tipically breed in the floem of weakened, stressed young pines. Field tests suggested attraction of females to baits consisting of either caged male adults or male frass and frass extracts.
Coupled MS-GC analysis of male hindguts have found amounts of grandisol (cis-2-isopropenyl-1-methylciclobutaneethanol) and traces of its aldehyde, grandisal, two compounds confirmed to be the main components of the deodar weevil Pissodes nemorensis in North America (Phillips et al., 1984). Preliminary tests have shown activity of sinthetic grandisol and grandisol to P. castaneus females in the field.

STUDY ON TRAPPING THE BEETLES MONOCHAMUS ALTERNATUS, ETC. BY USING ATTRACTANT. Lianqin Zhang, Shihan Son, Huanhua Huang(Forestry Reseach Institute of Guangdong Province, Guangzhou,China)

Attractants can be used to trap Monochamus alternatus in mass during the period of feeding and oviposition, and also to trap the beetles , such as Arhopalus unicolor, Hyposipalus gigaus, Shirahoshizo patruelis, etc. Using the self-compounded attractant the above-mentioned beetles increased by 0.29, 2.5, 3 and 1.2 times compared with the attractant of Japanese production respectively. The populations density of Monochamus alternatus, etc. and the rate of pine wilting can be greatly reduced after using attractant in the pine stand. Putting attractant No 1 into the pine tree and keeping for two months, the trapping effect was remarkable, especially in the first month.

POSSIBLE REASONS FOR PEAR THRIPS OUTBREAKS IN NORTHERN HARDWOOD FORESTS IN THE U. S. A. David A. J. Teulon, E. Alan Cameron, and Robert T. Hellested (Dept. of Entomology, Penn State University, University Park, PA 16802, USA)

In 1980 the pear thrips, Taeniothrips inconsequens (Uzel) (Thysanoptera: Thripidae), was identified as a pest of northern hardwood forest trees, particularly sugar maple, in the northeastern U. S. A. Reports of damage to forest trees by the pear thrips continued throughout the 1980's, with large outbreaks being recorded in 1988 and 1989. Based on two years of intensive sampling of a pear thrips population in a sugar maple plantation in central Pennsylvania, we report possible reasons for pear thrips outbreaks in northern hardwood forests in the U.S.A.

QUARANTINE OF LONGICORN BEETLES IN CHINA. Li-zhong Hua (Institute of Entomology, Zhongshan University, Guangzhou, 510275, China)

Since 1970s, 37 species of longicorn beetles imported with woods from abroad has known to China. These species occured in USSR, Korea, Japan, Indonesia, Sarawak, Singapore, Malaysia, Burma, Loas, Italia, Gabon of Africa and Guiana of South America respectively. Among them, some individuals of Japanese pine sawyer Monochamus alternatus Hope which are harboring the pine wood nematodes Bursaphelenchus xilophilus (Steiner and Burher 1934) Nickle 1970 have been introduced into Nanking from abroad, resulting pine wild disease on pine trees in 1982, the pine forest of Sun Yet-sen's Memorial park of Nanking was damaged, severely infested regions expanded to twelve counties around Nanking and Zhenjiang until 1988. And in 1988, the same disease was also found in some parts of Anhui and Shatoujio, Shenzhen of Guangdong Province. The name of Japanese pine sawyer Monochamus alternatus Hope has put on the list of imported pest quarantine of China.

INSECTS OF ORIENTAL BEECH IN IRAN, Mansour Abai, Plant Pests & Disaeses Research Institute, P.O.Box 1454, 19395-Tehran, Iran.

There are some insects species that are related up to now to Oriental beech as a host plant in Iran. The majority of them are bark and wood boring species-predomintly of the cerambycid family and a minority that attack flowers, buds, foliage or fruits, respectively. Except a very few host specific species these insects are more or less polyphagous, beech being only one of their host trees. Only a few species of insects attacking beech here, attracted recently more attention , no phloem/wood borer being amongst them. A curculionid beetle Rhynchaenus (Orchestes) fagi L. caused damage to foliage, shoots and acron of beech during mass occurrence in 1988/89 . Particularly severe was the damage in Mazandaran province with the consequence of noticeable loss in increment, loss in seeds and inhibition of natural regeneration.

#1

STUDY ON CROSS HEREDITARY EXPERIMENTS IN DENDROLIMUS SPP. Qing-shan Zhao, Wen-bo Wu, Guo-ping Lu (Forest Plant Quarantine and Pest Control Institute, Ministry of Forestry, Shenyang China), Xing Yuan, Shan-kui Li, Jia-cheng Jiang (Forest Plant Quarantine and Pest Control Service, Chongqing China)

In this paper, partial results of hybridization experiments between the Masson pine caterpillar Dendrolimus punctatus Walker (MPC) and the Chinese pine caterpillar D. tabulaeformis Tsai et Liu(CPC) was reported. Through conducting experiments on feeding habit, conspecific and interspecific pairing, sex pheromone and cross inheritance, it was found that MPC and CPC are actually of the same species. Because the differences in morphology, especially in anatomical form of genitalia, did not indicate the specific feature and interspecific reproduction isolation. Furthermore, reciprocal crosses (F generation) in the two insects both produced fertile progenies (F_1); F_1 and F_2 selfing produced normal F_2 and F_3 respectively. However, considering that, in China, certain differences did exist in morphological and ecological characteristics of these two insects, and their distributions are basically in accordance with their host trees, it is concluded that the CPC may be regarded as a subspecies of the MPC, and identified as Dendrolimus punctatus tabulaeformis (Tsai et Liu).

#2

GYPSY MOTH (*LYMANTRIA DISPAR* L.) DISTRIBUTION AND FLUCTUATION IN AMERICAN, EUROPEAN AND ASIATIC FORESTS. Romolo. Prota, P, Luciano (Istituto di Entomologia agraria, Unversità, Sassari, Italia) M. Peretto, M. Verdinelli (Istituto di Recerca sull'inquinamento ambientale, CNR, Sassari, Italia)

Investigations have been carried out in forest areas, abounding with species of *Quercus, Robinia, Populus* and *Salix*, by *ca* 50 research institutes and monitoring stations of 21 European, American and Asiatic countries to provide information relating to the intensity and periodicity of gypsy moth infestations. Elaborating the data (pheromone and light trap adult catches, egg-cluster counts per hectare and size of defoliated areas) has enabled three classes of infestation trend to be established:

1) with gradation of 5-7 years, zones in southern and eastern Europe;
2) gradation 8-9 years, most of Europe and North America;
3) gradation 10-11 years, Middle and Far East.

This variation in the dynamic cycles can undoutedly be attributed to environmental complexity and heterogeneity and to the different genetic structures of the populations. The problem of formulating a comprehensive and reliable model covering infestation periodicity merits further research into the trophic relationships with characterize the ecosystems involved and into external factors possibly affecting the ecological complex.

#3

PRACTICAL MANAGEMENT STRATEGIES OF THE PINE NEEDLE GALL MIDGE, Thecodiplosis japonensis, IN THE FRONTAL ZONES OF ITS INFESTATION. Buom-Young Lee (Forestry Research Institute, 207 Chongnyangni-dong, Seoul, 130-012, Korea)

The damages of pine needle gall midge, Thecodiplosis japonensis, has been essentially confined to the frontal zones of its range advancement in Korea. The midge-caused tree mortality began to occur from the pine stands having 60% shoot mortality and increased rapidly from 80 % or more. The pine trees having less needles in comparison with stem volume were high harzard from the midge damage, and the major stand/site factors relating to the harzard-rating for the midge were ground covering with undergrowth, aspect, position of slope, stand density, slope and slope form.

The pine stands prior to the midge invasion needed to be thinned to promote the tolerance for the midge damage. Reducing damage in the population increasing phase after invasion, systemic insecticide implanted into trunk proved to be effective. Phosphamidon implantation of 60% of total tree numbers by one time application at previous year of peak damage showed below 30% in shoot mortalities whereas 81% in untreatment.

#4

SYMBIOTIC FUNGI ASSOCIATED WITH *Xylosandrus crassiusculus* (Motschulsky) (COLEOPTERA, SCOLYTIDAE). H. Kinuura (Tohoku Res. Ctr., For. & For. Prod. Res. Inst., Shimo-Kuriyagawa, Morioka, Iwate 020-01, Japan)

Symbiotic fungi associated with the ambrosia beetle, *Xylosandrus crassiusculus*, was investigated by means of both isolation experiments and SEM microscopy in central Japan. Several fungi species were isolated from galleries in 4 different host species and from mycangia in which the beetles transmit fungal spores. The fungus composition in the galleries and mycangia changed greatly with the developmental stages of the beetles. The isolated fungi were classified into 3 groups : *Ambrosiella* sp., yeast like fungi, and the other fungi. In the galleries, *Ambrosiella* sp. was predominant at the egg/larvae periods in all host species. Yeastlike fungi were constantly isolated from the galleries, but dominant yeast species differed among host species. Among the other fungi, *Paecilomyces* sp. and *Cephalosporium* sp. were dominant species, and the rate of isolation of the two species changed greatly depending upon the host wood condition. These results indicate that *Ambrosiella* sp. was the symbiotic fungus species primarily associated with the *X. crassiusculus* (i.e. a primary ambrosia fungus), and that yeastlike fungi were auxiliary ambrosia fungi. The other fungi were considered to be non-ambrosia fungi.

#5

INELUENCE OF SITE QUALITY AND STAND CHARACTERISTICS ON OCCURANCE AND DEFOLIATION OF NEODIPRION XIANGYUNICUS. Heng-xiao Guo (Sichuan Academy of Forestry, Chiengdu 610081, China)

The influence of site quality and stand characteristic on occurance and defoliation of Neodiprion xiangyunicus was studied. It's found that There is a obvious influence of stand composition, plant in forestland and solpe position on eggs population dynamics, the order is stand composition> plant in forestland≥slope position> slope direction. thickness, stand age(no influence); There is a obvious influence of stand composition, plant in forestland, slope position and slope direction, thickness on immature larvae population. The order is stand composition> plantin forestland=slope position=slope direction=thickness> stand agge(no influence); There is a obvious influence of plant in forestland, slope position, stand composition, thickness and stand age on mediam and mature larvae population dynamics. the order is plant in forestland> slope position> stand composition>thickness=stand age>slope direction (no influence); There is a obvious influence of stand composition, slope direction, thickness and slope position on population dynamics of larvae crawling into soil, the order is stand composition>slope direction=thickness=slope position(has obvious influence). There is a serious influence of plant in forestland, thickness, slope position, slope direction, stand composition and stand age on feeding and defoliation dynamics, the order is plant in forestland> thickness>slope position>slope direction>stand composition, stand age (has influence). Stand composition, plant in forestland and slope position are the most important stand characteristics and site qualities which affect the occurance and defoliation of N. xiangyunicus.

#6

POPULATION DYNAMICS OF DENDROLIMUS PUNCTATUS AND DIVERSITY OF INSECT COMMUNITY IN PINUS MASSONIANA STANDS IN CHINA. Tian-sheng Li, Li-zong Ren (Research Institute of Forestry, Chinese Academy of Forestry, Beijng 100091, China)

Spatial and temporal simulation models of the population dynamics of Dendrolimus punctatus were established based on analysing and refining a great deal of research literatures about the pest. Input experimental data of 1989 into computer, the simulated results are cincided with the natural population dynamics (the pest outbreaks every 3 or 3. 5 years in natural conditions), which indicates the models established are good. In addition, the community in different conditions (different elevation and vegetables conditions) were compared. The results indicate that the community in the stands of higher elevation and better vegetables have more species and higher diversity indices. The communities of the stands in which the pest outbreaks have more species but lower eveness and lower diversity indices than the stands of the samenatural conditions in which the population densities are very low.

#7

THE BIOLOGY AND ECOLOGY OF THE LESSER PINE SHOOT BEETLE TOMICUS MINOR (HART.) (COL. SCOLYTIDAE) IN LEON (SPAIN). FERNANDEZ FERNANDEZ, M. M. (DEP. BIOLOGIA ANIMAL. UNIVERSIDAD DE LEON. LEON.), PAJARES ALONSO, J. A. (DEP. SISTEMAS FORESTALES. CIT-INIA. MADRID.).

The biology and ecology of the lesser pine shoot beetle Tomicus minor (Hart.) (Col. Scolytidae) was studied in Leon (Spain) during the period 1991-1992.

This beetle causes great damage in pine forest when the adult borrows and feeds into the pith of pine shoots to sexually mature before oviposition.

Studies under laboratory and natural conditions have been carried out in order to observe, overwintering, flight period, reemergence from brood logs, number of sister broods and shoot feeding of adult beetles.

Number of generations and their life cycle development are also shown.

#8

PRESERVATION TEST OF RUBBER WOOD WITH NEW WOOD PRESERVATION TWP. I. LABORATORY TOXIC TESTS. Zhenhua Shi, Shuqing Tan & Tushou Luo(The Research Institute of Tropical Forestry CAF, Longdong, Guangzhou, 510520, China)

The gum-producing economical life of rubber tree(*Hevea bresiliensis (HBK.) Muell.-Arg.*) is 25-30 years. In China, about 800,000 m^3 rubber wood will be produced each year and needed to be treated by preservatives to ensure wood products free from biodegradation. A new wood preservative TWP(provisional name) was developed at the Research INSTITUTE OF Tropical Forestry, Chinese Academy of Forestry. Results from the laboratory toxic tests of TWP showed that: 1) in controlling decay fungus(*Coriolus Versicolor (L. ex Fr.) Quel*) the threshold retention was at 2.2-3.2 kg/m^3; 2) in controlling bostrychid powder-post beetle (*Heterobostrychus aequalis (waterhouse)*) the threshold retention of killing egg-laying and larval was at 1.0 kg m^3; 3) in controlling blue-stain fungus (*Botryodiplodia theobromae Pat.*) and mixed mould fungi, the inhibition was at 1.0% and 1.5-2.0% respectively; and 4) on acute male mouse LD_{50} of TWP was at 1, 301 mg/kg.

#9

PRESERVATION TEST OF RUBBER WOOD WITH NEW WOOD PRESERVATIVE TWP. II. APPLICATION TRIALS. Zhenhua Shi, Shuqing Tan & Tushou Luo(The Research Institute of Tropical Forestry CAF, LongDong, Guangzhou, 510520, China).

Application trials of new wood preservative TWP were carried out in four wood factories in 1988-1990. The rubber green sawn can be successfully treated by full-cell or oscillating pressure processes with 2.0-2.5% TWP. Average net retention of TWP is at 4±0.7 kg/m3, and penetration in more than 20 mm, but anti-mold and anti-blue stain chemicals penetration about 10-15 mm. The preservation effect of the TWP is better than the mixed emulsion of ANTIBLU 3738(MBT+TCMTB) and ANTIBORER 3767 at concentration to 2%. TWP is safe in use to human, animals and environment. It is considered that TWP is a rubber wood preservative of low toxicity and may be instead of the complex of boron phenol which has been banned by some countries.

#10

STUDIES ON CONE INSECTS IN XINGCHENG SEED ORCHARD OF PINUS TABULAEFORMIS LOCATED IN LIAONING PROVINCE, CHINA. Zhen-yu Li, Xi-huan Shen (Beijing Forestry University, Beijing 100083, China), Run-zhi Zhang (Institute of Zoology, Chinese Academia, Beijing 100080, China)

In 1987, an investigation was carried out in Xingcheng Seed Orchard of P. tabulaeformis and it was found that: during the period from the florescence of female cone to the end of the year, (1) the one-year cone output loss caused by Cecidomyia sp, Dioryctria pryeri, and default of fertilization is :44.5%, 22.4%, 12.3% separately; and the total loss reaches to 81.4%; (2) the two-year cone output loss caused by Petrova cristata, Dioryctria rubella is 19.3%, 2.7% respectively, and the total is 57. 7%. The damage time process of these agents was also studied. In addition, the chemical control experiments with Sumicidin (20Ec) , Malathion (50%), Decis (2.5%), Fenitrothion (50%) , and Omethoate (40%) were performed to control the Lepidoptera pests; if the control is opportune, the cone seed yield can rise 0.86 to 2.96 times. The control experiment on Cecidomyia sp. is in progress.

#11

PRELIMINARY RESEARCH ON PESTS OF LOBLOLLY CONES AND SEEDS. Cuncheng Wang, Jin Shi, Hong Zhang (General Station of Forest Protection, Anhui 230031, China)

In 1991, the basic investigation on cones and seeds of loblolly pine was carried out at Maanshan forest farms. The results showed: 1 Five species of pests were found: Petrova cristata (Walsingham), Dioryctria rubella Hampson, D. pryeri Ragonot, a thrips and a midge; 2. 35. 2 percent of loblolly cones was destroyed by pests at coning stage, which was measured by using a cohort life table approach, the pest-infesting peaks were in June and August; 3. 2671 matured cones were dissected, among which the percentage of healthy cones, light, middle and heavy damage cones were 20. 2%, 8.3%, 14.8% and 56.9% of total ones respectively, a thousand seed's weight and seed viability were 26. 6g, 26. 5g, 22.7g, 16.4g, and 70%, 68%, 36%, 7.7% respectively in above different groups.

#12

STUDIES ON THE BIOLOGY AND INTEGRATED MANAGEMENT OF ACANTHOSCELIDES PALLIDIPENNIS. Mingchen Gao (Forest Protection and Quarantine Station, Qiqihar, Heilongjiang 161006, China)

Acanthoscelides pallidipennis is a kind of harmful insect damaging the seeds of Amorpha fruticosa. It was discovered in quarantining seeds which supported by Heilongjiang Province to Gansu in 1983. Studies on its distribution, morphological character and biological characteristics were carried out. The results showed the northeast threshold of its distribution should be Mudanjang area in Heilongjiang province, and at the same time some new discoveries differing from the information known before were gotten. Some of the new discoveries filled the gap of the study of this pest in our country.

#13
CHARACTERISTICS OF LARVAL DEVELOPMENT AND DAMAGE-CAUSING OF EURYTOMA PLOTNIKOVI NIKOLSKAYA (HYMENOPTERA. EURYTOMIDAE) AND ITS CONTROL. Shi-bo Tian, Xing-rui Jin, Shu-e Zhao(Plant Protection Institute of Hebei Academy of Agriculture and Forestry, Baoding 071000, China.)

Eurytoma plotnikovi Nikolskaya, distributed in north of China, is a exterminatory insect pest on Pistacia chin ensis Bunge, a oil-bearing crop. From 1970s to now, there have been nearly no harvest of P. chimensis because of damage of this insect. In the recent studies, we discovered that the larval devclopment of E. plotnikovi is well related to the seed embryo development of P. chinensis. Until the expansion of the seed embryo, the larvae keep in the first instar unless they hatched earlier or later. In this period, they cause litter damage. It was found that spraying high concentration (2500-5000ppm) of monocrotophos in the period from the end of oviposition to the seed embryo expansion can kill 80-90% of the larvae in the fruits.

#14
STUDIES ON THE BIONOMICS AND CONTROL METHEDS OF ATRIJUGLANS HETAOHEI IN SHANXI. Rui Wang, Qin-shen Li (Isntitute of Plant Protection, Shanxi Academy of Agricultural Sciences, Taiyuan 030031, China) , De-ming Wu, Yun-hua Yian, Jiong-run Cui (Institute of Zoology, Academia Sinica, Beijing 100080, China), Lu-ji Zhao Jing-xi Zhang (Forestry Bureau of Yu County)

Atrijuglans hetaohei (Lepidoptera, Heliodinidae) is one of the most important pests which damage the walnut. The insect distributed nearly all over the walnut production region in Shanxi province. Investigation shows that about 30% walnut trees were damaged by the pests. The average loss rate caused by the pests was 36.8% . In some places the loss rate was up to 47. 7% . Some places had no production year after year. Studies show that the eggs of the insect were oviposited in a cross of main vein and branch vein on the back leaves of walnut tree. The female mated less than 6 times in a life, average 2.95 times.

One generation of the insect is carried out for a year. The old larvae overwinter in the soil under the crown of the tree. According to the bionomics of the pest, we adopted the IPM, including turnning up the soil deeply under the shade of the tree, cleanning up the weeds, leaves, branch and the damaged walnut, spreading pesticide both in the surface of soil and on the leaves of walnut tree, good results were obtained.

#15
THE PRELIMINARY STUDIES ON THE BIOLOGICAL CONTROL OF TWO WEEVILS OF CHESTNUT. Jin-ci Wang (Spread Station of Forestry Technology, Jinshan, Hubei 431800, China)

Curculio davidi and Cyllorhynchites ursculus were two main pests of chestnut in Hubei. The harm of weevils had greatly effects on the quality and the yield. Chemical control was more difficult and also impaired the quality and the colour. Combining intercropping and farming of chestnut garden with using biological pesticide had achieved good results of controlling weevils on the basis of the characteristic of the larvae living through the winter on the topsoil. The ovipositing fruit branches of falling to the ground were collected once every seven days, and then they were amassed and burnt in order to reduce the source of the weevils. To spread high yield and resistant variety of chestnut also effectively controlled the harm of the weevils.

#16
A STUDY ON BIONOMICS OF STENOLECHIA RECTIVALVA KANAZAWA AND ITS CONTROL. Qing-min Hou(Department of Plant Protection, Hebei Agricultural University, Baoding 071001, China), Jiu-wei Bai (Institute of Zoology Academia Sinica, Beijing 100080, China).

The present paper deals with a study on bionomics of stenolechia rectivalva Kanazawa, It was a new important insect pest on flower of chestnut trees, and was first discovered by writers in China. In Hebei province this insect was the most injurious and abundant in the chestnut producing districts of Yan-mountain arca. The larvae bored into and damaged the male flower or female flower of mixed inflorescence, which may became withered and fell,yield reduction severely. This insect propagates one generation per year, winter is passed as a pupa inside a silken cocoon under bark crevice or loose barks. Most adults are present from late in May to early in June. The egg are laid on male inflorescence at early stage and on mixed inflorescence at late stage. Larvae feed in flower from early June to July, then leave and remove to twigs. Pupation take place at the late June sometimes lasts to middle of July, the pupa stage continues about 11 months. Chamical control applied on blossom period of male inflorescence and stripped the barks are considered as the most effective ways to control this insect.

#17
INTEGRATED PEST MANAGEMENT OF MANGO ON HAINAN ISLAND, CHINA. Jun Zhang (Hangzhou Animal and Plant Quarantine Service, Hangzhou 310021, China) ,Lian-tian Xi (China National Rice Research Institute, Hangzhou 310006, China)

Mango (Mangifera indica) suffers great loss in yield due to damage caused by insect pest. Among the 80 species insect pests of mango on Hainan Island, the Mango hopper (Idiocerus spp.) , Branch borer (Rhytidodera bowringii White), Fruit flies (Dacus dorsalis Hendel) are the three major pests. An experiment on the integration of cultural, chemical and biological control measures for the management of pest complex of mango was conducted on Hainan Island from 1982 to 1985.

The program of an integrated control measures is as follows: 1. Improvement environmental conditions in mango plantation viz., Removal and destruction of host plant and breeding place; 2. Establishment of an insect population monitorlng system; 3. Using insecticides when the flower-bud begin to form and mango leaf-hopper lays eggs in the tissues of inflorescence. Eradication of fruitflies with attractants. Burn the infected branchs and plug the holes below affected area on the stem with cotton soaked in 20% Fenvalerate with the aim to kill the larve of branch borer after mango fruit harvest.

Most mango plantations on Hainan Island are established alongside tracts of native vegatation which belong to complexity and heterogenty agroecosystem. long term stable habitats generally exhibit an extensive speces diversity. Quite often natural control in effective for many pest population, but when a population outbreak dose occur and method of control are required, care should be taken so that the disturbance of natural control factor should be kept to the minimum.

#18
STUDIES ON INTEGRATED CONTROL METHODS OF CARPOSINA NIPOEENSIS WALSINGHAM IN JUJUBE TREES. Wang-gang Zhang, De-yi Zhang, Yan-hua Liang (Forestry Bureau of Linfen City, Shanxi 401000, China)

Carposina niponensis is one of the major pest of jujube trees in the north of China. We studied the pattern of the development and integrated control methods during 1987-1991. Now we report the four main control methods as follows: (1) We collected covering soils of 5 cm depth within the limits surrounded jujube trees 1m, sieved the cocoons and destroyed them in spring season, reducing the pest population density. (2) Covering the ground with plastic film within the limits surrounded jujube trees 1m, it can depressed the overwintering larvae. (3) Luring and killing the adults with lamp and sex hormone in the periods of adults prosperous happening. (4) Spraying the insectcides in the ground in the jujube trees shades. It can killed a great deal of larvae. We have integrated four controlling method for five years and got the good results that the pest population density from 93% reduced to 0.3%.

#19

A STUDY ON CYDIA TRASIAS (MEYRICK). Xue-ying Chen (Beijing Forestry University, Beijing 100083, China)

This study focuses on the distribution of hibernation larvae (HL) of Cydia trasias (Meyrick). Survey showed that it overwintered mainly in the fruit and some times under the bark crack of the trunk below 0.5m. The rate of fruit damaged by this pest was between 18.8-71.3%. A pair of black kidney marks on the back of larval abdomen can be used to distinguish the female and male. Controlling suggestions: Striking out the fruit which has pest larvae in it, using sexual attractants (female mates only one time in its life), spraying insecticide during the egg-laying period of adult.

#20

DAMAGE AND BIOLOGY OF *PISSODES PINIPHILUS* IN ESTONIA. Anne Luik (Department of Plant Protection and Horticulture, Estonian Agricultural Academy, Tartu 202 400, Estonia)

In South-east Estonia about 2000 sparse pine (*Pinus sylvestris*) stands of 20-70 years of age are damaged by *P.piniphilus*. The stands grow on the poor sandy soils which at times are stressed by deficit of water and some nutrition components. Frequently the stands are weakened by *Bupalus piniarius* or by fungi *Heterobasidion annosum*.

P.piniphilus inhabits the pine trunks in the part of thin bark . The population density is very high on the trunk at the crown part (until 2529 larvae per m^2) where they also inhabit the branches. The survival rate of larvae depends on the physiological state of the host tree. If the resin pressure of the tree is high, then all the larvae perish in the young instars. On the weakened trees the mortality rate of larvae is 50-70%.The females lay the eggs over all the summer and larvae of different instars, hibernate. The supercooling points of the last instars larvae were in September -9,3...-11,5° C and in January -27...-35° C.

In the larval galleries the entomophages are rare. Most common among these are some *Braconidae*.

#21

EVIDENCE OF GENETIC RESISTENCE OF MILICIA (ODUM) TO AN IMPORTANT GALL FORMING INSECT. Joseph R. Cobbinah (Forestry Research Institute of Ghana, Kumasi, Ghana), Michael R. Wagner (School of Forestry, Northern Arizona University, Flagstaff, Arizona 86011, USA).

Milicia spp. (odum) is a high value commerical timber species in tropical Africa. The species is fast diminishing within its natural range as a result of a combination of heavy exploitation and failure of natural regeneration. A gall forming psyllid (Phytolyma spp.) has been identified as the major cause of failure of natural regeneration and plantations.

Considerable variablility in infestation intensity has been observed and there is evidence of genetic resistance of Milicia to the gall forming insect. Resistant genotypes are attacked, however, galls that form on resistant genotypes are abnormally small. Galls on susceptible genotypes burst to release the adults; galls on resistant genotypes do not open. The expression of resistance is a function of genetic and environmental factors.

#22

BIOLOGY AND CONTROL OF THE BLACK PINE BAST SCALE, MATSUCOCCUS THUNBERGIANAE, IN KOREA. Seung-Chan Park (Dept. of Forestry, College of Agriculture, Chonnam National University, Kwangju 500-757, Republic of Korea)

The black pine bast scale, Matsucoccus thunbergianae Miller and Park, was first found in the southwestern coastal area of the Korean peninsula in 1983. Since discovery, the scale has been expanding its range about 5 km per year damaging the forests of Pinus thunbergiana. It is a univoltine bisexual species which overwinters in the second instar. Adults emerge in early spring. An apparent obligatory summer diapause in the first instar was terminated by low temperatures.

Sixteen species of predatory arthropods have been found. Dense pine forests have been thinned before or during the invasion of the scale. However, it appeared that those natural enemies and silvicultural practices were not enough to evade serious damage in the frontal zone of infestation. Trunk injection of phosphamidon (Dimecron 50% Lq), 0.6 ml per cm D.B.H., treated in December caused 87.4% mortality of the feeding nymph.

#23

PREVALENCE OF AN ENTOMOPATHOGENIC FUNGUS, *HIRSUTELLA CITRIFORMIS* ON LEUCAENA PSYLLID, *HETEROPSYLLA CUBANA*, IN MALAYSIA. Ahmad Said Sajap and Mashita Mahmod, Department of Forest Management, Universiti Pertanian Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

The leucaena psyllid, *Heteropsylla cubana* Crawford (Homoptera: Psyllidae) is a serious pest of a multipurpose tree, *Leucaena leucocephala* (Lam.) (Leguminosae) in Southeast Asia, Pacific Islands, Hawaii and Australia. Even though the pest is already widespread throughout Malaysia, no information on the entomopathogens associated with this insect has been recorded. This study reports the prevalence of an entomopathogenic fungus, *Hirsutella citriformis* Speare (Deuteromycotina: Hyphomycetes) on the leucaena psyllid, *H. cubana* in Malaysia. Result from monthly sampling of the psyllid over a period of one year shows that the psyllid, was susceptible to infection by the fungus, *H. citriformis*. Dead psyllids were found mummified and cemented by cream coloured mycelia onto the leaves and branches of the leucaena plant. The result also shows that the adult psyllids were more prone to the fungal infection than those of the nymphs. The adult population had an infection rate ranged from 11 to 20% while the nymph had an infection rate of less than 2%.

#24

NEW SPECIES OF CARDIASPINA CRAWFORD (HEMIPTERA:PSYLLOIDEA OUTBREAKS ON EUCALYPTUS OCCIDENTALIS ENDL. IN SOUTHERN WESTERN AUSTRALIA. Farr, Janet Dawn, S.G. Dick (Department of Conservation and Land Management, Research Division, Manjimup, Western Australia, 6258, Australia.

Eucalyptus occidentalis grows in swamps and along creek-lines in the Lower Great Southern of Western Australia. Since clearing for agriculture this eucalypt species mainly exists in remnant stands of vegetation. In 1982 large numbers of trees were observed to be dying due to an outbreak of a new species of psyllid in the genus Cardiaspina. This poster outlines the biology of this insect and current studies being conducted into its ecology and population dynamics.

#25

ECOLOGICAL AND MORPHOLOGICAL DIFFERENCES BETWEEN TWO SWIFT MOTHS, *ENDOCLYTA* (=*PHASSUS*) *SINENSIS* AND *E. EXCRESCENS* (HEPIALIDAE: LEPIDOPTERA) IN JAPAN. M. Igarashi (Kansai Research Center, Forestry and Forest Products Research Institute, Momoyama, Fushimi, Kyoto 612, Japan)

Two swift moths, *Endoclyta sinensis* and *E. excrescens*, feed on various kinds of both woody and non-woody plants, being agricultural and forest pests in Japan. These two species, however, had been often confused with each other for a long period, because few studies had been conducted under natural conditions. I have found some ecological and morphological differences between these two species. The main differences are summarized as follows.

	E. sinensis	*E. excrescens*
1.Adult flight season	mid summer	late summer and fall
2.Duration of egg stage	about 2 weeks (non-diapausing)	about a half year (diapausing)
3.Larval character	abdominal segments 4-7 without coloured markings on dorsum	abdominal segments 4-7 with dark brown markings on dorsum
4.Pupal character	frons to pronotum shining with deep wrinkles	frons to pronotum dull-shining with shallow and irregular wrinkles
5.Feeding site	beneath the ground	above the ground

#26

GROWTH RATE OF APHIDS AND LEVELS OF MONOTERPENES IN SCOTS PINE SEEDLINGS EXPOSED TO OZONE

J.K. Holopainen, P. Kainulainen & J. Oksanen. (Ecological Laboratory, Department of Environmental Sciences, University of Kuopio, P.O.Box 1627, SF-70211 Kuopio, FINLAND).

One-year-old Scots pine (*Pinus sylvestris*) seedlings were fumigated with 300 ppb (6h/day, 3 d) and 600 ppb (6h/day, 2 d) ozone. To determine nymphal growth rates of large pine aphid (*Cinara pinea* Mordv.) and grey pine aphid (*Schizolachnus pineti* L.) the aphids were transfered on the seedlings just after the end of the exposure experiments. Mean relative growth rate (MRGR) of *S. pineti* was significantly reduced on pine seedlings exposed to 600 ppb ozone and 95 % of nymphs died during the experiment. MRGR of *C. pinea* was slightly reduced in ozone-exposed seedlings, but the differences were not significant.

There were no changes in needle monoterpenes of pine seedlings exposed to 300 ppb ozone. Visible symptoms were observable and concentrations of some individual monoterpenes and the water content of the needles were significantly reduced in seedlings exposed to 600 ppb ozone. However, there were no changes in total monoterpene concentrations. The results suggest that acute exposures to the high levels of ozone could reduce the suitability of pine seedlings to aphids.

#27

APHIDS INFESTING STREET TREES IN WARSAW. Elzbieta Cichocka (Department of Applied Entomology, Wojciech Goszczynski Agricultural University of Warsaw, Poland)

Mapples, linden and oaks of Warsaw streets are numerously infested by sucking pests such as aphids, leafhoppers and spider mites. Chewing arthropods occurred in small numbers causing no damage. *Eucalipterus tiliae* was found on liden. Population density of those aphids was many times higher on the street trees than on the trees grown in the parks stands near forest. *Periphyllus aceris* and *P. testudinaceus* were numerous on mapples but *Drepanosiphum platanoidis* and *Periphyllus lyropictus* were rare. Up to 700 aphids were sometimes found on a leaf, and all leaves were infested. Leaves of oaks were also infested by aphids. Up to 800 aphids per leaf were noted. *Phylloxera coccinea*, *Tuberculoides annulatus* and *Tuberculatus querceus* were feeding on oaks.

The aphids were accompanied by parasitic hymenopteras, coccinellids, larvae of hover flies, lacewings and cecidomyids, which also were more numerous than at natural stands. After 7 years of observations, it was found population density of sucking insects is regulated by: (1) Climatic conditions of vegetation season: aphids were more numerous after mild winters and during raining seasons. At the some time, the spider mite density was low. (2) Natural enemies.

#28

OCCURRENCE, LIFE HISTORY, AND MANAGEMENT OF PEAR THRIPS IN SUGAR MAPLE STANDS IN PENNSYLVANIA. E. Alan Cameron, D. A. J. Teulon (Dept. of Entomology), L. H. McCormick, and T. E. Kolb (School of Forest Resources, Penn State University, University Park, PA 16802, USA)

Taeniothrips inconsequens (Uzel) (Thysanoptera: Thripidae), has damaged Acer saccharum (Marsh.) stands in Pennsylvania and other northeastern United States in recent years. The insect is univoltine, living as larvae, pupae, and adults from May through March in the soil. In the spring, at approximately the time leaf buds swell and leaves expand, adult thrips emerge from the soil, move to tree crowns, feed, and oviposit. Larvae feed, molt once, complete leaf feeding, and drop to the ground.

Development of management tactics and strategies must take into consideration the phenological synchrony of the insect and its host. Use of chemical pesticides may create unacceptable residues in a food crop (maple sap syrup). If appropriate exotic parasites can be identified, cultured, released, and established, biological control may be possible. Predators do not appear promising; most potential predators are polyphagous. Pathogens, especially fungi, may cause mortality during the time thrips are in the soil; exploitation of fungi will present major challenges. Implementation of controls will be difficult, and any use ultimately will depend on economics.

#29

STUDIES ON ARGE CAPTIVA SMITH. Gong-yi Wang, Zhen-qing Wang, Quan-sheng Liu, Jing-you Peng, Shu-rong Lin(Forest Protective Station in Yongqing County, Hebei Province, China)

Arge captiva Smith is one of the most serious insect pests, which attacks Ulmus pumila Linne. In recent years, it was found to cause severe damage in Langfang Region, Hebei Province. It has two generations a year in the region. Matured larvae overwinter populously in the cocoons in soil. The higher the soil moisture is, the shallower the larvae stay in the soil, on the contrary, the smaller the deeper. There is a close relationship between the occurrence period of overwintering larvae and the amount of precipitation. With the early precipitation, the pupation of overwintering larvae and the emergence of the adults are also early. The control experiment in 3 years shows that there are two critical periods to control it in a year, that is, the occurrence period of overwintering adults in the first ten days of June and the pupation period of mature larvae for the first generation in the first ten days of August. In the two periods, the insect pests are intensively moving about on the ground, and it is easy to spray chemicals and save labour without killing natural enemies. Phoxim and parathion capsule are used to shut off the pest. The mortality can reach over 90%.

#30

A STUDY ON THE COCCOTORUS BEIJINGENSIS LIN ET LI. Kai-jin Lin (Beijing Gardens School, Beijing 100061, China)

The Coccotorus beijingensis Lin et Li is a new species reported by Kai-jin Lin and Gui-xiu Li in March 1990, and Genus Coccotorus is a new record to China. This paper gives a brief account on biology and control measures of this insect. The insect has only one kind of host, Celtis bungeana BL. This insect only has one generation a year in Beijing region and overwinters as adult at the gall. The adult stage is about 200 days, and it come out of the insect gall in early March the next year and mating. The female lays eggs into the buds or on the top of twig in middle March. It's eggs hatch into larva in early April and they harm in twigs to make galls. The larval stage is about 130 days. The study also showed that by using the 24% Lannatel 500 times and 40% Omethoat 1000 times mixture, or 50% Methamidophos 1000 times and 24% Lannated 500 times mixture, one time of spray in early larval stage can reach 100% control efficacy, but when the sprays were conducted in the time of adult comes out from the gall twicely, the accumulative control efficacy, can also reach 100%

#31

A STUDY ON THE BIONOMICS OF *SATASPES TAGALICA CHINENSIS* CLARK Lin Bangchao, Gong Qijing (Forestry Committee of Shaxian County, Fujian, China, 365500)

The Sphingid moth *Sataspes tagalica chinensis* Clark is one of the worst pest of *Dalbergia balansae* Prain. This insect has three generations per year and overwinters as pupa in the soil in Shaxian, Fujian Province. The adult moths begin to emerge in early April next year and the female moths lay eggs individually on the tender leaves. The egg stage lasts for 4 to 11 days. The larvae generally have five instars lasting for 21 to 49 days. The pupal duration is 15 to 20 days for the first generation, 21 to 28 days for the seeond and 157 to 226 days for the third. The rate of pupal eclosion of the first, second and third generation is 88.6%, 91.4% and 64.7% respectively. The spans of life are 4 to 8 days for female adults or 3 to 7 days for male adults. Spraying with 90% Dipterex (1:1000), 80% Dichlorvos (1:1500) or 2.5% Deltamethrin (1:4000) are effective to control the larvae. Collecting the fourth to fifth instar larvae manually and loosening the soil to kill the pupa in winter are effective as well.

#32

STUDIES ON THE BIONOMICS AND CONTROL OF CHROMAPHIS JUGLANDICOLA KALTENBACH Li Jian-ping Chen Qi-xing Zhang En-liang Yue Jian-guo(Research Institute of Garden Science of Taiyuan, Shanxi 030012, China) Wang Guang-zhi (Forestry Bureau of Xiaoyi County, Shanxi)

The species and genus of Chromaphis juglandicola Kaltenbach are all the new record to China. The aphid does harm to cultivated walnut tree Juglans regia, in Shanxi. About thirty per cent of walnut trees suffer seriously. From 1987 to 1989, author made a systematic study to this aphid. Generation of winged virginogeniae is 12 to 14 in a year. The average nymph first age is 3.6 days, second age 2.2 days, third age 2 days, fourth age 3 days. The number of young deposited by a single adult ranges between 14 and 41. The number of sexual oviparous females is 2. 7 to 21 times as much as males. The number of egg deposited by a single sexual oviparous female ranges between 7 and 21 grain. Major natural enemies are ladybug (contains variety and aberration), chrysopa and predaceous mite etc. about nineteen kinds. 22 to 23℃ are more favorable temperature of growth of the aphid. Approach 24℃, developmental rate begin to slow down. Over 25℃, population number lessen. Of low (April or May, or May, under 6.5℃) and high (July, over 35℃) temperature extremes, may cause many indiridual death. Under high density, the aphid body grows obvious smallness. Its length is only 52.6% to 94.2% of normal state. Using 35% Phosalone and 50% Pirimicarb control the aphid, to its major natural enemy less injury as well as high effect. The treatment can raise 22.4% of output of single plant of walnut tree.

#33

STUDIES ON THE UROCHCTA QRADRINOTATA REUTER Xu Shouzhen Meng Xhangxiao Wu Jiangong (Station of Forest protection and Quarantine, and Jinzhong Forest Bureau, Yuci 030600, Shanxi Province, China)

Urochcia quadrinotata Reuter distribute over Korea, Japan and north of China It only injures white elm tree in jinzhong area. From 1981 to 1984, the peat often broke out and plagued, and more than two million white elm trees died of the injurys. The pest sucks its host's trunk, branch and leaf in the stage of adult and nymph. The tree becomes died-up and dead in the right year or the Spring of next year.

The pest has one generation a year and adults overwinter in Jinzhong area. Next Spring, dehibernated adult mates while feeding. It's nymph has five instars and the habit of 4th or 5th instars is similar to the adult's . It's occurence related with forest topograph, manegement measures, host age, tree's develop state and natural enemies.

Currently, the pest is controlled mainly by planting trees and using chemicals. Protecting and using of two hunting bugs (natural enemies) are helpful to control the pest.

#34

THE RESEARCH AND APPLICATION OF HPT MONITORY AND PREVENTION. Mingsheng Pu (Forestry Monitory Station Ganzhou, Jiangxi, 341000 China)

Hemiberlesia pityso phila Takayi(HPT) was discovered in May, 1982, in the wasson pines in Zhuhai, Guangdong, which is very close to Macao. HPT is a kind of quarantine insects, which spread rapidly and is rather harmful. It is one of the important steps to monitor and prevent them in the anti–insect campaine. In recent years, an epidemic situation from North Guangdong is threatening Gannan. In order to take mrasures to prevent the spread of the insects, we have organized studies of the methods of monitory and prevention and planned a 210–kilometre–long and 10–kilometre–wide monitory zone. Eleven monitory stations and 603 sub–stations have been set up. The observations have been made regularly at some temporary–standard and permanent–standard fields, along with all–round investigations of the epidemic situation, espeically the current one. At the same time, we also enforce the quarantine checks, combining cure with prevention. As a result, we obtained a series of practical, simple and effective methods to prevent HPT spreading.

#35

A STUDY ON THE WHITE PEACH SCALE AND ITS CONTROL IN PAULOWNIA FORESTS OF SOUTHERN SHANXI , CHINA . Yingping Xie, Tianwen Cao (Department of forestry of Shanxi Agricultutal University, Taigu 030801 , China) , Shufang Pei , Guangshou Yang(Forestry Bureau of Yongji County in Shanxi , China)

The white peach scale, Pseudaulacaspis pentagona(Targ .) infests seriously in paulownia forests in the Southern Shanxi Province.There is 3 generations one year. Important natural enemies are Aphytis sp . and two predators, Chilocorus kuwanae and Cybocephalus nipponicus . The control experiments showed that the key time to control this pest is in the first instar stage of nymph . Spraying with 40% Diamethoate 1000 time solution and 40% Methamidophos 1000 time solution can get 88. 4-92. 8% mortality. Painting 2 poison rings around the tree trunk with abover two pesticides in 1-5 time solution can get 90. 2-92. 8% mortality, when mixed with half mount of the slow release formulation can greatly raise control effect. Boring holes and injecting the two pesticides in at base of trunk with 6-9ml/per tree, the mortality of the scale reached 96.4-100%. Appling Temike, a kind of granule pesticide 40-60g for each tree under the surface soil nearly the roots , the scale insect can be killed 95.4% or so.

#36

THE INFLUENCE OF EXTRAFLORAL NECTARIES ON PARASITISM OF GYPSY MOTH (LYMANTRIA DISPAR) IN KOREA. R.W. Pemberton and J.H. Lee (Asian Parasite Laboratory-USDA-ARS c/o American Embassy, 82, Sejong-no, Chongro-ku, Seoul 110-050, Korea)

Extrafloral nectaries are sugar secreting glands, usually found on leaves, that have been shown to promote ant defense against the insect herbivores of many plants. Season-long collections of gypsy moth larvae were made at five sites near Seoul, from trees which bore extrafloral nectaries (primarily Populus spp.) and from trees that lacked the glands (primarily Quercus and Castanea spp.). The larvae were reared in the laboratory on Quercus leaves to allow for parasitoid emergence. Larvae collected from trees with extrafloral nectaries experienced 32.1% parasitism versus 21.8% parasitism for larvae collected from trees without the glands. Extrafloral nectar feeding by adult parasitoids probably increased their contact and parasitization of larvae living on trees that had the glands.

#37
CHINESE FOREST PLANTS QUARANTINE. Shu-ying Wang (Ministry of Forestry, Hepingli, Beijing 100714, China)

From Qing dynasty to 1949, China had no FPQ work. After the founding of new China, the well-known forestist Liang Xi-ren set up the organ of prevention & control of forest plants diseases. It was the first national professional organ on our country.

In 1964, the EPQ organs in the southern & northern areas of China & directly under the command of the FM were ratified by the State Council.

From then on, the organs have carried out effective work in FPQ. Since the adoption of the reform and open-door policy, this work has developed more quickly.

Except Tibet in mainland China, 29 provinces, autonomy regions & municipalities directly under the central government have already set up provinceal level organs of FPQ.

Now there are altogether more than 1899 FPQ organs at various levels, & more than 110,000 stalls. Besides over 4000 disease prediction stations have been built up, & a FPQ network of four levels (national, provincal, regional, prefecture & county)has been formed.

At the same time, remarkable successes have been achieved in training personnels, restraining forest diseases & protecting forest resources.

According to China forest developing project from 1991 to 2000, FPQ work will be more strengthened. The priority will be given on equipment & prediction work.

#38
APPLICATION OF CHEMICAL CONTROL IN PINE CATERPILLAR MANAGEMENT. Zhou-zhi Li (Nanjing Forestry University, Nanjing 210037, China)

The pine caterpillar is the most serious major pests historically in the forest of china. From the begining of the eighties, the integrated management of pine caterpillar has been arranged into a major research project in China. We have built some sample forests for the integrated management of pine caterpillar through ten years tests and obtained an effective way of controlling pine caterpillar, which have been systematically summarized in theory and practice. We have done a synthetic review how to reasonable applying technique of chemical control in integrated management of pine caterpillar.

First is areawide population management for controlling the damage of pine caterpillar. The places of pests source or occurrence of pests will be continued controlling after decreasing high density of pests, so that the level of the density of population could be lasting lowered stably, and not damage to the forest. The pyrethroids is the most effective, economic and reliable major insecticide for controlling the pine caterpillar. The benzoylphenol urea is also a desirable bionics agent to pine caterpillar management nowadays in China.

#39
SEX ALLOCATIONS OF THE TWO PARASITOID WASPS, Atanycolus initiator (FABRICIUS) AND Spathius brevicaudis RATZEBURG (HYMENOPTERA: BRACONIDAE), ON SUBCORTICAL BEETLES IN JAPANESE PINE TREES. T. Urano (Kansai Research Center, Forestry and Forest Products Research Institute, Fushimi-ku, Kyoto 612, Japan), N. Hijii (School of Agriculture, Nagoya University, Chikusa-ku, Nagoya 464-01, Japan).

A. initiator (AI) and S. brevicaudis (SB) are the major solitary ectoparasitoids of subcortical beetles infesting Japanese pine trees. They have almost identical life histories, coexist most frequently in the same trunk utilizing the same host complex. Size characteristics and sex allocation patterns of the two wasps in relation host size were examined by rearing experiments on various host species.

AI had much larger body size than SB, but the emerging wasp sizes of both species were significantly correlated with the sizes of major host species. AI parasitized exclusively larger hosts such as mature larvae of Shirahoshizo spp. (Curculionidae) whereas scolytid larvae and young lavae of Shirahoshizo spp. were attacked favorably by SB. Coexistence of AI and SB in the same trunk was thus suggested to be most likely due to the difference in host size preference between the wasps. In both AI and SB the male proportions of emerging wasps declined with host size, but no differential mortalities were observed between wasp sexes. For the same host species, Shirahoshizo spp., the sex ratio of AI was much more male-biased than that of SB, suggesting that the sex ratio shift with host size may be caused by the differences in host availability between AI and SB.

#40
TRAPPING CYPRESS BARK BEETLE *PHLOEOSINUS AUBEI* PERRIS WITH HOST PLANT'S VOLATILES. Ren Gui-fang (Beijing Institute of Landscape and Gardening, Beijing 100061, China), Liu Meng-ying (Institute of Zoology, Academia Sinica, Beijing 100080, China)

Phloeosinus aubei Perris is one of the important pests of cypress (*Platycladus orientalis*) in China. The relations between host plant and the beetle's aggregation were investigated in this study. The results showed that the odour of cypress had a strong influence on the selection of host and aggregation behavior of the bark beetle. The beetles, specially females, were attacted by the extracts of arborvitae bark. The results of field trials demonstrated that numbers of *P. aubei* were captured by the traps baited with the essential oils of the bark and turpentine oil. It is likely to show that the extracts of arbovitae bark and turpentine oil may be used in forecasting and trapping the cypress bark beetle.

#41
BIOGEOGRAPHICAL PATTERNS OF NORTHERN EUROPEAN FOREST INSECTS. Kari Heliovaara (Finnish Forest Research Institute, P.O. Box 18, SF-01301 Vantaa, Finland), Rauno Vaisanen (Water and Environment Research Institute, P.O. Box 250, SF-00101 Helsinki, Finland).

Existing distribution maps of forest insect species were analyzed in order to reveal biogeographical patterns in northern Europe. These presence/absence data derived from 70 x 70 km quadrate or provinces were classified and related to environmental variables using multivariate methods (TWINSPAN, DCA, CCA). Each insect group exhibited zones in a south-north direction, but the region was also divided in east-west direction in Scolytidae (Coleoptera) and Saltatoria but less clearly in Buprestidae or Cerambycidae (Coleoptera). The observed distributional patterns agreed roughly with vegetation zones presented earlier, but the extension of southern vegetation zones northwards along the Atlantic coast can hardly be discerned. Temperature variables associated with latitude were the most significant determinants of the biogeographical variation in the species assemblages.

#42
AGGREGATION BEHAVIOR OF THE PINE ENGRAVER BEETLE, IPS PINI (SAY)(COLEOPTERA: SCOLYTIDAE) IN RESPONSE TO IPSDIENOL AND LANIERONE. S.J. Seybold, D.L. Wood Department of Entomological Sciences, University of California, Berkeley, CA 94720, USA), S.A. TEALE (Department of Biology, SUNY, Syracuse, NY 13210, USA)

A population of Ips pini in California was analyzed for production of and flight response to two aggregation pheromone components, ipsdienol and lanierone. Males produced predominantly R-(-)-ipsdienol (92%--98%-R-(-)) and trace quantities of lanierone (< 0.002% amount of ipsdienol). In studies with enantiopure ipsdienol (> 99.7% e.e.), R-(-)-ipsdienol attracted both sexes in a dose-dependent manner, while S-(+)-ipsdienol inhibited that response dose-dependently (significant inhibition between 1% and 10% S-(+)-ipsdienol). Adding four doses of lanierone to 99.4% R-(-)-ipsdienol (1 mg per day release rate) elicited a significantly higher flight response than ipsdienol alone, though the response to lanierone was not dose-dependent. A fifth dose of lanierone (2 mg per day, highest release rate) significantly reduced the response to ipsdienol.

The pheromone production-response characteristics for this population of I. pini differ considerably from another population in eastern North America, suggesting substantial evolutionary differences in the pre-mating behavior of these populations.

#43

THE SEASONAL DYNAMICS OF MIGRATION OF ARBOREAL INSECTS IN OAK FOREST IN WESTERN SLOVAKIA. Ľubomír Vidlička, Milan Kozánek, (Institute of Experimental Phytopathology and Entomology, Slovak Academy of Science, Ivanka pri Dunaji, CSFR), Oto Majzlan (Comenius University, Faculty of Sciences, Department of Zoology, Bratislava, CSFR).

The seasonal dynamics of migration of arboreal insects was studied in a oak forest near Budmerice, Slovakia, with tree stem traps during two years (1985-1986). The traps were placed at various heights. In total 8300 specimens from fifteen orders of insects were colected by 5 (or 6) traps. Orders *Dermaptera*, *Heteroptera*, *Lepidoptera*, *Hymenoptera*, *Coleoptera* and *Sternorrhyncha* were represent eudominantly.

Quantitative changes in insect density activity througout the year were important for all eudominant orders. Spring peak of activity was connected with the beginning of growth of leaves. Phytophagous *Lepidoptera* (larvae), *Coleoptera* and *Heteroptera* move up the tree crowns in spring. Summer peak of activity coincident with migration of pantophagous and zoophagous *Dermaptera*, *Coleoptera* and *Hymenoptera*. Autumnal peak of activity was recorded at *Sternorrhyncha* (Aphidinae), pantophagous *Dermaptera* and *Coleoptera*. The insect density activity was particularly depressed in July and October, clearly depressed during winter (december-april).

Besides host phenology, the air temperature and relative humidity have also influence to the seasonal variance in density activity.

#44

POPULATION DYNAMIC FORECAST OF PINE CATERPILLAR (DENDROLIMUS PUNCTATUS) BY BLACKLIGHT TRAP. Wei Jiansheng (Guangxi Forest Research Institute 23, Yongwu road. Nanning Guangxi 530001. China)

This study on the population dynamic forecast of pine caterpillar by using blacklight trap to trap the mothes was conducted in the pine caterpillar integrated controlling experimental forest located in a forest farm near Qinzhou city of Guangxi province, China. Eight years data from more than thirty generations of the pine caterpillar were systematically analysed. Models for forecasting the occuring time and number of the pine caterpillar were established and proven effective in their applications. As there was a close relation between the emergence period and the temperature in spring of a year, forecasting models for the emergence, medium emergence and high emergence of the adults of each generation were established respectively as follows, $Y_{11}=48.4958-0.7706X_1$; $Y_{12}=38.9041-0.6257X_1$; $Y_{13}=40.8251-0.2189X_{11}$; $Y_{21}=66.9207-0.5889X_{21}$; $Y_{22}=61.1556-1.6621X_1$; $Y_{23}=86.5136-0.3608X_{11}$; $Y_{31}=76.7812-0.5617X_{11}$; $Y_{32}=67.932-0.4258X_{32}$; $Y_{33}=71.231-1.227X_{11}$. The trend of the occurence, the development and rough numbers of the occurence of the population of the next generation could be forecasted by using the population index of expectation value (I) and (L) ($I=N_t/N_{t-1}$)($L_{t-1}=L_{t-1}\cdot I$). Forecasting models were also respectively established for the relation between the number of the mother trapped (X)and the density of eggs ($Y=0.000461X^{0.87056}$), the density of the larvae ($Y=0.1363+0.005X$), and the density of the pupae ($Y=0.0005X^{1.2055}$) of the next generation as there was a very significant relation between the number of the mothes trapped and population size of the eggs, larvae and pupae of the next generation.

#45

STUDIES ON OCCURRENCE TYPES OF DENDROLIMUS PUNCTATUS WALKER IN ANQIN DISTRICT, ANHUI PROVINCE . Jiansheng Zhou, Guiying Ding, Yulu xia, Jing Shi(Anhui Forest Biological Control center, Hefei 230031, China) Pengfei Hu, Guanghua Wu, Xiling Sun

The present paper studied the difference of three occurrence types of Dendrolimus punctatus during the period of 1986-1990.

1.Frequently outbreaking districts: Elevation of the districts is lower than 400 meters. Accumulated temperature is equal to 5049℃ with average temperature surpassing 10℃ ,and 2984℃ with average temperature surpassing 25℃ a year. Human disturbance is freqent, the facies of wood are simple,and trees are pruned extraordinarily. Cover plants are mainly herbs, number of natural enemies is fewer than other districts. The pest occurs every 3 years in general.The area of this type accounts for 30-40 of total area.

2.Casual outbreaking districts: Elevation is between 400-800 meters. Accumulated temperature is equal to 3752℃、 819.95℃ of average temperature 10℃、 25℃ a year respectively, the district can not be a place of the pest gathering. Human disturbance is seldom, the facies of wood are sophiscated. Cover plants are mainly bush,number of natural enemies is more than that of frequently outbreaking distict. The pest outbreaks every 7 to 10 years.

3.Districts of safety from the pest: Elevation is higher than 800 meters.Winter is very cold and summer is cool and damp in this district.Dendrolimus punctatus is never outbreaking or seldom outbreaking.

#46

RECENT ADVANCES FOR SCIENCE AND TECHNOLOGY ON FORECAST INSECT PESTS IN CHINA. Xian-qing Xue, Li Cui, Yan Qi (Nanjing Forestry University, Nanjing 210037, Jiangsu, China)

Since 1980's, the advance of science and technology on forecast of forest insect pests in China has been made rapidly. The published reports on this area are more than 576. They can be classified several fields as follows:

1. The research on the general investigation and fauna of forest insects.
2. The research on the technological measures of forecast of forecast of forest insect pests.
3. The research on the application of advanced science and technology to forecast of forest insect pests.
4. The research on the models of space distribution and the methods of sampling forest insect pests.
5. The research on the methods for examining the amount of forest insect pests on high and big trees.
6. The development and application of life table of forest insect pests.
7. The research on mathematical statistic forecast of forest insect pests.
8. The research on forecasting with trap lamps.
9. The research on applying pheromone to forecast of forest insect pests.
10. The research on the basic theories about forecast of forest insect pests.
11. The research in other fields of forecast of forest insect pests.

#47

MASSON-PINE CATERPILLAR (DENDROLIMUS PUNCTATA WALKER) POPULATION DYNAMICS AND ITS FORECASTING MODEL. Run-jie Zhang (Research Institute of Entomology, Zhongshan University, Guangzhou 510275, China)

Masson-pine caterpillar completed its development of three generations one year in Fengkai County, Guangdong Province. Its fourth or fifth instar larvae in the third generation overwintered in late December and recovered feeding activity in late February next year. There was a cycle with 3-4 years in its population dynamics. During the peak period, the density was 44.5 larvae per pine tree and that was 11.3 in other period. The growth index of the 1st, 2nd and 3rd generation were 1.1, 1.5 and 1.3 respectively.

The population dynamics was influenced by the following factors: the temperature in January, February and June, the rainfall in April, the relative humidity in July and the density of post-overwintering. It was shown that the transition probability of three status (serious, middle, and light) was 1, 0.73 and 0.5 respectively.

Several models were developed to predict the population tendency, including Markov chain model, stepwise regression model and time series model.

#48

STUDIES ON BIOLOGY AND CONTROL OF FALL WEB WORM HYPHANTRIA CUNEA (DRURY). Changyi Yu (The General Station of Forest Plant Disease and Pest Control, Ministry of Forestry, Shenyang 110031, China)

Fall web worm Hyphantria cunea (Drury) is a widely distributed forest insect pest, that was found in the district of Dan Dong in 1979. Its morphology, biology, and population dynamics were studied. The author introduced and discussed the control methods of Fall web worm in this paper.

#49

A STUDY ON THE BIONOMICS OF TWO LARCH BUD MOTHES(ZEIRAPHERA LARICIANAKAWABE, Z.GRISECANA HUBNER) DAMAGING LARCH. Guo-feng XieXin Li, Hua-ming Bi, Guo-yi Han, Min Xie(Saihanba Forest Farm of Hebei Province, China).

The two larch bud mothes, Zeiraphera lariciana Kawabe and Z. griseeana(Hubner), seriously attack the larch(Larix principis-ruppreehtii Mary) in Saihanba Forest Farm. The distributing area of the two pests overlap in the farm. They distribute in the elevation of 1600 to 1900m. The habit of them are similar. They have one generation a year and overwinter as egg on the trunk, branch and old cone. The larvae have five instars and attack the tree in the early growth stage of the larch. In the middle ten days of June the matured larvae get down the tree and get into the litter to make cocoon and pupate.

The middle ten days of July, the adults begin to emerge. The female adults complement nutration for six days, and then they deposite eggs. The female adult of Zeiraptera lariciana Kawabe can live 16 days and one female of which can produce about 41 eggs. The female of Z. griseeana(Hubner) can live 27 days and each female can deposite about 171 eggs. Four species of parasitic insects of the two pests are found. They are Trichogramma sp., Tranosema sp., Aseogaster sp., Phacogenes sp.

#50

MORTALITY OF PONDEROSA PINE FEMALE STROBILI IN CALIFORNIA, OREGON, AND WASHINGTON. *J.D. Stein* (Pacific Southwest Research Station, USDA Forest Service, Berkeley, California, 94701 USA), R.E. Sandquist (Pacific Northwest Region, USDA Forest Service, Portland, Oregon, 97208 USA)

The USDA Forest Service has designated ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) as a high priority species in reforestation and tree improvement programs in the western United States. During 1987 and 1988, several study areas were established in California, Oregon, and Washington to determine the occurrence and effect of mortality agents during the 2 years of female strobilus development. In general, total cone mortality varied from 14% to 59%, depending upon geographic location and year of study. Insect-induced mortality to female strobili was not significant until the second year of cone development. Insects accounted for up to 24% of cone mortality. Among insect pests, the ponderosa pine cone beetle (*Conophthorus ponderosae* Hopkins) and a coneworm (*Dioryctria* sp) were the two that killed the most cones.

#51

STUDIES ON THE OCCURENCE AND THE CONTROL OF INSECT PESTS OF ELM TREES IN SHANXI. Fu-rong Wang, Xiu-qin Shi, Yong-xin Chen (Institute of Corn, Shanxi Academy of Agricultural Sciences, Xinzhou 034000, Chna), Yu-tian Wang (Control Station of Forest Diseases and Insect Pests of Shanxi Province, Taiyuan 030012, China)

Since 1980, elm trees (Ulmus pumila) have been damaged seriously by insect pests in Shanxi. A large number of 5-10 years old elm trees was attacked to death. This paper reports that there are more than 120 species of elm trees pests in Shanxi. Illiberis ulmivora Graeser, Lvela auripes (Butler), pyrrhalta aenescens Fairm, Anoplophora glabripennis (Motsch), Cossus cossus mongolicus Evschoff and Urochela quadrinotata Reuter are widespread distribution and serious damage. The biological properties, occurence and control methods of the insect pests have been researched and got some good results. This paper also points out synthetic control counter-measures in the future.

#52

THE RESEARCH OF EFFECT OF MAIN PESTS ON BEARING IN CHINESE FIR SEED ORCHARD. Fan-jun Qian (Department of Forestry, Nanjing Forestry University, Nanjing 210037, China), Yu-zhen Weng, Rong-zhuo Yu, Bin-lin Zheng (Yangkou.Forestry Farm, Fujian province 353211, China)

A study on the pests in chinese fir seed orchard was made in Fujian province et al from 1988 to 1990. The results show that there are 26 species belonging to 7 orders and 20 families in Chinese fir seed orchard. The 3 species of them-Dichomeris sp. (Lepidoptera: Golechiidae), and Sinorsillus piloferus Usinger (Hemiptera: Lygaeidae), and Polychrosis cunninghamiacola Liu et Pai (Lepidoptera: Tortricidae) were main pests of effecting on the bearing in chinese fir seed orchard. Dichomeris sp. was a new record species in China. The average rate of cone damaged was 13.6% (1.8-43.1%) in China. This paper reports their biology and effect on the bearing in chinese fir seed orchard.

#53

STUDIES ON THE CONTROL OF Lepidosaphes salicina Borohs. Yu-xiu An (Station of Forest Protection and Quarantine, Changzhi046000, Shanxi, China), Li-zhong Wang(Station of Shanxi Forest Protection and Quarantine, Taiyuan030012, Shanxi, China), Hong-lian Cheng(Xianyuan Forest Bureau, Xianyuan046200, Shanxi, China).

Lepidosaphes salicina Borohs is a quarantine species in forest of our country. In resent years, its injuries get more and more serious and caused a lot of popular trees to be dying. In the past, the methods of spraying and injecting pesticides were used, which not only wasted labours and chemicals , but also killed natural enemies and so on. The tests adopt various manipulations by using different insecticides, concentrations, widith, periods and types of painting. The results are as follows: 1. It has yielded remarkable effect by the method of painting rings with 40% Monocrotephes and 40% Oxy-Diemethoate. The method of painting rings(mortality 93-98.5%, effective height 5.89m) is much more notable than that of spraying. 2. The best manipulations of painting ring are: 5%(concentration of chemicals)×3cm(width of ring), bdh under 7cm; 50%×5cm, bdh between 7-15cm and 50%×7cm, bdh over 15cm, respectively. 3. The period of painting rings should be started from the 30% nymphes hatched to the coming 7th day of the end of hatching. The high time for chemical control is between May 20 and 30. 4. The mortability is a bit higher by using painting than that of spraying, morover the former needs only 1/3 amount of pesticides of the latter's.

#54

THE INJURIOUS INSETS ON THE ROOTS OF PINUS ELLIOTTII. Jijian Wang (Bo Bai Forestry Farm of Guangxi, Guangxi 537617, China)

It has been 25 years since the Pinus elliottii was introduced from America and Planted in Bo Bai forestry farm of Guanxi. We have found that Philus antennatus, Holotrichia lata, Anomala cupripes, Platypleura hilpa and Capritermes nitobei make inroads on the roots of Pinus elliottii. Among them Philus antennatus, Holotrichia lata and Anomala cupripes could destroy the middle age forest. Several ways to prevent and control these pests are discussed and biology characteristic of pests are described.

#55

A STUDY ON *UNASPIS EUONYMI* (COMSTOCK) (HOMOPTERA DIASPIDIDAE). Guihua Bai, Sichun Zhang, Meiqin Cheng, Jun Liu (Nanjing Garden Bureau, Nanjing 210000, China)

Unaspis euonymi (Comstock) is an important pest on euonymus plants, which belongs to the family of Diaspididae. It is found in provinces of Guangdong, Guangxi, Sichuan, Shanxi, Shandong, Shannxi, Liaoning, Jiangsu *etc.* in China. Studies on the morph, distribution and bionomics and host plant of this pest were carried out during 1982–1986. The results showed it breeds three generations annually in Nanjing area and the overwintering stage is female adult which impregnated from November to middle March in next year on host plant branches. The hatching peak periods of the nymph from the first to third generations are in the middle May, late June and middle August, respectively and the female adults appear in the late May, late June and late August, respectively. The sexual ratio is 1:2.4(♀ :♂). The numbers of eggs laid per female is 11~ 147 with the average of 70 or so. The hatching rate of the first generation egg is 96%, but the mortality is up to 20–30% . Adults and nymphs mainly damage the leaves and branches of over biennial host. Some main natural enemies are also described. For its effective management strategies, strengthening host plant resistance to pest and utilizing of insecticides at the hatching peak of nymphae are emphasized.

#56

A STUDY ON HETEROPSYLLA CUBANA CRAWFORD, A NEW PEST OF HORTICULTURAL PLANTS IN FUJIAN, CHINA. Huang Bangkan, Liu Shijun, Huang Changqing (Department of Plant Protection, Fujian Agricultural College, Fuzhou, Fujian 350002, China)

Heteropsylla cubana Crawford is an important pest of Leucaena glauca (L.) Benth. The pest was first discovered in Cuba in 1914, and to 1985 its damage and outbreak were reported by many countries and areas of the world. In this paper the research situation of the pest in the world is reviewed, and the description and biological observation are made in Fuzhou during 1990-1991, after the invasion of the pest into the mainland of China.

H. cubana is a new pest of horticultural plants in China. It appears in the middle of May, and then the population is keeped at low level. As the population increases after September, the number of nympha is highest in the early of October, and the peak of adults is from the late of October to the late of November. After then the population decreases and it almost disappears in February next year. Under the mean temperature 20°C in the field, a generation passes 18-20 days. The duration of egg develops 5-6 days, and nymph with 5 instars requires 13-14 days. From the investigation the pest is distributed in many areas of Fujian Province, China.

#57

STUDIES ON STEPHANITIS (STEPHANITIS) SVENSONI DRAKE. Liu Li (Forestry Bureau of Shamen, Fujian 361001, China)

The tingid bug Stephanitis (Stephanitis) svensoni Drake is an important pest of the Chineses Sassafras (Sassafras tsumu (Hemsl.)) in Fujian Province.

This paper reports the results of studies on the biological characteristics and control of the pest during 1986-1988.

The pest has six or seven generations each year and overwinters with the adult stage. The adults begin to appear on trees in April. Their eggs are laid in the leaf tissue and the egg stage lasts 4-24 days. There are five instars in the nymphal stage which lasts 9-41 days.

The DDVP and Malathion smoke agent, Phoxim, DDVP or Trichlorphon are effective against the nymph and the adult.

#58

STUDIES ON THE POPULATION DYNAMICS AND CONTROL OF PEST MITES ON *ERYTHRINA ARBORESCENS* ROXB.
Ding Wenchuan, Zhen Zhizhong, Ma Yue (Landscape Architecture Research Institute in Chongqing, 630021 China)

This paper investigated the species of red mites and their natural enemies, as well as the damage and the population dynamics of the red mites. There are 2 pest mite species: *Panonychus citri* (McGregor), *Tetranychus cinnabarinus* (Boisdaval) and their main natural enamies are *Stethorus punctilum* Weise, *Scolothrips takahashi* Priesner, *Amblyseius nicholsh* Ehara et Lee. There are 3 peak occurence of the pest mite populations and the first peak is of the most serious damage to *Erythrina arbrorescens* Roxb. Experiments on pesticides in laboratory and in field has shown that Nissorun, Comite, Folimat, Sumicidin sprayed 10 days before the first occurence peak time are very effective in controlling the pest mite populations.

#59

FOUR NEW SPECIES AND TWO NEW RECORDS OF THE SUBFAMILY TINTHIINAE FROM CHINA (LEPIDOPTERA: SESIIDAR). Xu Zhenkuo (Qinghai Academy of Agriculture and Forestry, Xining, Qinghai 810016, China), Liu Youqiao (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The present paper deals with four new species and two new records of subfamily Tinthiinae, Seiidae occurring in China. The new species are: *Zenodoxus rubripectus, Z. meilinensis, Z. simifuscus, Z. tianpingensis*. The new records are: *Pennisetia hylaeiformis (laspeyres), P. contracta* (Walker). The genus *Pennisetia* Dehne is recorded for first time to China. All specimens are preserved in the Institute of Zoology, Academia Sinica and the Qinghai Academy of Agriculture and Forestry.

The genitalia of both sexes of these species are described and figured.

#60

A STUDY ON TWO NEW PESTS OF MIRIDAE (HEMIPTERA) INFESTION FLOWER BUDS OF JUJUBE. Zhi-hua Zhang (Station of Forestry Protection, Fanchang County, Anhui 241200, China)

This paper reports the study of two new pests: Eurystylus sp. and Lygocoris sp. of Miridae (Hemiptera) which infest flower buds of jujube. The development of bugs synchronizes with the fifferentiation of the flower of jujube, the bugs suck and shrivel flower buds, and the pathogenic fungus (Fusicoccum sp.) can earily invade. In severe condition, flower buds are distroyed resulting in fruitlessness. The infestation of the flower bugs to Fanchang long jujube, one of the good equality jujubes in China, have been the main factor for fruitlessness. Our research revealed the causal agents. Dirtribution: Fangchang and Xuancheng Counties, Anhui Province, so far found in China.

#61

A STUDY ON BIOLOGY OF CHINONASPIS MICROPORI MARLATT (HOMOPTERA: DIASPIDIDAE) AND ITS CONTROL. Shu-qin Qiao, Mang Shu (Yanbian Forestry Bureau, Yanji 133001, China)

Chinonaspis microporis is a very dangerous pest of branchstem of poplar and willow. The biological characteristics and control measures have been studied in the Changbai Mountains in 1987-1989. There was one generation each year. Its eggs overwintering inside the scale on the trunk hatched into larvae in the middle and last ten days of May. At the beginning of June, the first-instar nymph began to shed and showed differences of sex. At the beginning of July, the second instar nymphs shed. Adults could be found in the middle ten days of July. There winged and unwinged male adults, male copulate immediately after emergence and then died the crevices of bark. From the middle ten days of August to the last ten days of September, female adults laid 30-78 eggs per adult.

The effectivenesses of three insecticides have been tested. The best controlling effectiveness achieved 90% by spraying 20% Sumicidin at the beginning of nymph stage. In 1988 and 1989, this method had been used in 10,695 mu at total and the average effectiveness was above 90% .

#62

RESEARCHES ON THE BIOLOGY AND CONTROL OF A POPLAR-PEST-QUADRASPIDIOTUS PERNICIOSUS COMSTOCK. Fabang Liu, Shaowen Wang, Jixing Zhao (Foresty Bureau of Weifang, Shandong 261041, China), Jian Ren (Garden Department of Weifang, Shandong 261041, China)

Quadraspidiotus perniciosus Comstock is distributed in 15 proviences in China, and also occurs in Europe, America and Australia etc. 160 kinds of plants are damaged by it, including peach, pear, apple, poplar and willow etc. It occurs three generations a year. The nymph natural mortalities of the first, the second and the hibernating generations are 51.6%, 60.8% and 73.6% respectively. Damaged by the pest for 3, 4 and 5 years, the stand volumed of poplar (Poplar euramericuna (Dode) Ginier cv. Robusta) decreased by 10.8% 39.2% and 58.2% respectively compared with that of healthy stands. The natural enemies of Q. perniciosus are Chilocorus kuwanae Silverstri, Prospaltella aurantii Howard etc. 97.8% effeetiyeness of control could be got by sprayiag with 1000-time of 40% omethoate emulsion, 1200-time of monocrotophos emulsien and 1500-time of phesphamidch emulsion. the effectiveness was 99.47% when smearing the trunk with 5-time of omethoate. The all pest died when smearing Q. perniciosus with 7-time of omethoate.

#63

STUDIES ON THE CONTROL OF THE PINE NEEDLE ARMOURED SCALE(*HEMIBERLESIA PITYSOPHILA* TAKAGI) WITH PLANT AND DIESEL OIL EMULSIONS. Meiliang Wu(Dongguan Institute of Agricultural Sciences, Guangdong, 511715, China)

Laboratory,insectary and field experiments on the control of the pine needle armoured scale,*Hemiberlesia Pityophila* Takagi, with some plant oils(Chinaberry seed oil,neem oil,rubber tree seed oil) and diesel oil emulsions were conducted from 1989-90 in Guangdong Province.The results showed that the seed oils had a strong settle-down deterrent effects on the newly hatched nymphs(crawlers). In choose or non-choose experiments,a deterrent effect of 80-90% on 1 day or 5 days after spraying with 2% the three seed oils was obtained. The LC_{50} for the female scale by Chinaberry seed oil+diesel oil,rubber tree seed oil+diesel oil,and rubber tree seed oil were 1.60%, 1.44% and 0.86% respectively. The LC_{50} for the 2nd instar nymph were 1.12%, 0.84% and 0.61% respectively. A mortality of 91.4% -94.8% by spraying with a 5% rubber tree seed oil+diesel oil,and rubber tree seed oil+diesel oil+diazinon (1:1000),was obtained. 75kg/ha(1:4) rubber tree seed oil in admixture with diesel oil was very effective by aerial spraying. These oil emulsions are safer than organic insecticides to the main natural enemies of *H. pityso-phila* and the fish *Clenopharyngodon idellus*.

#64

A REPORT ON THE STUDY OF ELM LEAF BEETILE CONTROL THRESHOLD,Xia-qin E, Jia-lin Liang(The Forest Pests and Diseases Control Center of Hebei Province, Shijiazhuang 050051, China) Guang-feng Jin (Botou forest Pests and Diseases control Center, Hebei) Guo-xian Li(Hengshui Forest Pests and Diseases Control Center, Hebei) Zhen-gang Li, Cao manzhi,(Renqiu Forest Pests and Diseases Control Center, Hebei)

Elm leaf beetle(Pyrrhalta aeneseens Fairm) is one of the most important defoliating pests in the middle and southern plain area of Hebei. There are two generations in one year, some individuals have third generation. Through group raising and individual raising from 1987 to 1989, we get the average individual leaf eating amount of adult and larva in every generation. We pick separately 30%.50%. 100% and 0% whole tree leaves from the stand and test trees by hand, and get the average leaf number, average leaf area on 50 centimeters long branch. In 1989, after tree stopped growing, we measured and calcalated the wood growth amount of standard test trees. At last, after analysis of statistical figures calculating the money spending on pest control, the control threshold was determined as: average adults (over winter generation) population is 15 on 50 centimeters long branch or 6 on 100 leaves. It is tolerable that elm's leaves were damaged below 50%.

#65

A STUDY ON LIMASSOLLA DIOSPYRI CHOU ET MA. Li-juan Liang, Xiu-rong Qiao, Su-ping Guo (Hebei Forestry college, Baoding 071000, China.) Gao-sheng Guo (Qian nan yu village, Xingtai County, Hebei 054013 China.)

Limassolla diospyri Chou et Ma, a pest that suck juice of the leaves of persimmons, is distributed over Hebei, Shanxi, Hunan province and Beijing municipality. In the western mounteinous areas of Hebei province the insect reproduce two or three generations per year, and survive the winter in the cambia of one year old branches by its ova. when occuring on a large scale the insect can be controlled by spraying canopies or painting trunks with 40% omethoats, or injecting the insectcide to the base of stems by boring holes. Its natural enemies are Zanchius tarasovi, Gorpis japonicus, and Pseudoloxops guttatus et al.

#66

A PRELIMINARY STUDY ON THE YUNNAN PINE RESIN MIDGE. Yong-zhi Pan(Southwest Forestry College, Kunming 650224, China)

Twelve species of the genus Cecidomyia have been reported from north America and Eurasia. They are known as pine resin midges infesting mainly the pines and also spruce and fir.

The species studied was first discovered in a Pinus Yunnanensis plantation of Jiang-Bian Forestry Bureau, Mi-Le County in 1973. The larvae feed on the resin of new twigs retarding the tree growth. The infestation has now extended to approximately 6000 hectares reaching an injury rate up to as high as 79.6-100% including killed trees in some seriously infested stands.

The morphological characteristics of the pest is described The biological and ecological characteristics of this resin midge is closely studied to provide a reference for suggestin the management measures of the pest. The key factor analysis based on its 5-generation life-table data has shown the potential of developing natural biological control in the infestation area, preliminary pest management strategy and tactics are suggested in the text. They have been implementing during recent years at some heavily infested pine stands with promising results.

#67

A STUDY ON DIORYCTRIA SYLVESTRELLA. Wen-min Lu, Feng Tian, Xiang-hong Bi (Heilongjiang Research Institute of Forest Protection, Harbin 150040. China)

Dioryctria sylvestralla is an important insect of Korean pine. It damages cone and stem or new shoot. It distributes only in Heilongjiang province. There is one generation a year in Heilongjiang province. The larvae are borers and overwinter in the galls of pine. They begin to move in the last ten days of April. Duration of larva is 330 days. larva damages phloem and causes death of trunk. Harmful period of Larva is more than 110 days. Larva stage has 5 instars, larvae pupate the in last ten days of May. Duration of pupa is 15 days. The adults emerge in the middle ten days of June, then mate and oviposit. Eggs were oviposited nearly or above flower buds, wounds and spots caused by disease. New larvae incubate in the last ten days of June and overwinter in September.

#68

PRELIMINARY OBSERVATIONS ON THE PHENOLOGICAL CHARACTERS DURING THE OCCURRING PERIOD OF PINEUS CEMBRAE PINIKOREANUS Zhang et Fang. Feng Tian, Wenmin Lu, Xianghong Bi, Anming Wang, Gotao Shen (Forest Protection Research Institute of Heilongjiang Province, Harbin 150040, China)

The relations between the development of Pineus cembrae pinikoreanus Zhang et Fang in a year and the seasonal characteristic changes of the animals and plants around the pest have been investigated as follows:

When Ulmus laciniata (Trautv.) Mayr. begins to flower, many overwintering larvae of the pest appear; When U. laciniata is in full flowers, the first eggs of the pest are found; When Taraxacum spp. is in full flowers, the first generation larvae of the pest increase greatly in number; When the fruits of U. laciniata drop numerously, a great number of the second generation eggs of the pest occur; When the numerous seeds of Taraxacum spp. fly in the air, the second generation larvae of the pest increase in number; When the young needles of Pinus koraieusis Sieb et Zull disperse completely, the color of the third generation eggs deepen; When green young needles change into deep green ones, the third generation appear; When the fruits of P. koraieusis are brown-green, the fourth generation eggs may be observed; When fruits brown, the fourth generation larvae are going to overwinter.

#69

STUDIES ON THE NATURAL PREDATORY ENEMY AND THE POPULATION FLUCTUATION OF PINEUS CEMBRAE PINIKOREANUS ZHANG ET FANG. Fang Tian, Xianghong Bi, Gotao Shen, Wenmin Lu, guizheng Hui, Jianwen Cai (Forest Protection Research Institute of Heilongjiang Province, Harbin 150040, China)

Studies on the natural predatory enemy and the population fluctuation of the pest from 1989 to 1991 indicate that there are 21 species of natural predators. Among them, Didea fasciata Macguart, Syrphus torvus O sack and Leis axyridis (Pallas) Var. novemdecimsignata Faldermann are the dominant species. Because these dominant species and the overwintering, the first and second generations of this pest occur at the same time, the predators can attack all generations of this pest continuously. Thus the population density of the overwintering, the first and the second generations decreased by 70% in this case and an obvious effect of control is observed.

#70

AN EXPERIMENT REPORT ON CONTROLLING THE PINE WILT DISEASE BY THE COOPERATION OF CHINA & JAPAN. Ming-hong Ge (Forestry Bureau, Department of Agriforestry of Jiangsu Province, Nanjing 210008, China)

The pine wilt disease is a dangerous disease of pines. The main spread medium is Monochamus alternatus. In order to look for better ways of controlling it, we cooperated with the experts from Japan to do the experiment. The main method is cutting the disease trees and treetment, and controlling the aduls with pesticides. The pesticides are MPP Emulsion, which diluted one hundred times, and MPP Oil, which diluted thirty times. The solution is kerosene. Spray period is from May 20 to 27, 1991. Main conclusions are as follow:

1. MPP Emulsion is a kind of long-term effect pesticide which has better quality of systemic, it can kill the imagos of beetles effectively. If spray pesticide in the begin and peak period of its eclosion, the rate of dead pine can be greatly decreased at the same year. It can be used for the control of new-found, or isolated disease areas and important scenic spot. 2. The best period to treat the disease wood with MPP Oil is Oct. to dec. It can be used for high mountains, which traffic is not convenient, especially for the treatment of stumps, this way can greatly decrease the worker's intensity and cost. 3. The beetles are affected by weather condition, especially temperature and rainfall. 4. The distance of beetle's natural spread is limit, normally, no more than 100m, so, the key measure to control the spread of disease area is to control the spread by people.

#71

A PRELIMINARY STUDY ON *CRYPTOTYMPANA ATRATA*. Zhong-lang Hu, De-xiang Shi, Chong-xuan Han (Shaanxi Institute of Forestry Science, Yangling, Shaanxi 712100, China)

Cryptotympana atrata (Fabr.) is important branch-boring pest for poplar, ulmus, apple etc.. Our observation showed that five years are required for the pest to complete a generation. The pest overwinters in soil as larvae and in branch as egg. The adult occurs from the early of July to the middle of August. And the oviposition of the adult begins on the middle of July, the peak time of egg-laying on the middle of August, the egg period is from 260 to 345 days. The longevity of the adult from 45 to 60 days, the sex ratio is 1:1. The male adult likes to sing. There is the cybotoxis and the social property for the adult, the space distribution pattern of the adult in the forest concides with the aggregated negative binormal distribution. The effective control measures include the selection of the varieties of poplar resistance to the damage of cicade, cut branch-egglaying in winter, dusting or atomizing chemical pesticides on the crown and forestland, potting ammonia water and interval corn.

#72

RESEARCH ON BIONOMICS AND SPATIAL PATTERN OF THE LARVAE OF WILLOW GOAT MOTH, Cossus cossus monglicus Erschoff, IN WILLOW TREE Xue-rong Li (Forestry Dept. of Shenyang Agric, Univ., Shenyang 110161, China).

the larvae of the willow goat moth is investigated in willow tree-one of the main border trees in Shenyang City in1990-1991. The border-willowtree in Shenyang city is seriously damaged by the larvae, The tree can not grow well and its appreciation value is also reduced due to the damage. The bionomics of the larvae is recorded and their spatial pattern is measured.

#73
THE STUDY OF BACTERICERA MYOKYANGI (KLIMASZ-EWSKI). Lihua Sun (Forestry School of Liaoning, Shenyang 110101, China)

This kind of insect is dispersed widely, and harmed varied willow-tree. There are five generations in Shenyang in a year. The adults overwinter and replenish nutrition in the first ten days of April. In the second ten days of April, adults mate and produe eggs. Its eggs are produced in the back or tooth of the leaves. The body of nymph is flat form, flying in the surface of leaves and secreted white wax piece. There are five instars. Oxidetion dimethoate 20-40 times liquid is applied to treetrunk and killed nymph. There is a good result. The author discussed the integrated control of this insect pest in this paper.

#74
STUDIES ON THE SCALE INSECTS OF THREE PROVINCES OF NORTHERN CHINA. Gongtian Xu (Shenyang Administrative Office of Green Planting, Shenyang 110015, China)

Since 1973 a wide survey of scale insects from Northern China consisting of Liaoning, Jilin and Helongjiang was carried out by the author. The present paper deals with five parts: the first part relates to the landforms and geographical conditions of Northern China; the second part discussed distributive characteristics of scale insects; the third part enumerates the damage characteristics of the scale insects in Northern China; the fourth part approaches the tactics to control scale insects; and the last part arranges the list of the scale insects of three provinces of Northern China. A total of 80 species belonging to 47 genara in nine families are enumerated in this list.

#75
INVESTICATION ON OCHROPLEURA FINNICA TAUSCHER AND ITS BREAKING-OUT IN THE BURNED AREA OF THE GREAT XING'AN MOUNTAINS. Jin-kuan YANG, Yu-hua Shao(Institute of applied Ecology, Academia Sinica, Shenyang 110015, China), Shu-cai Han, Li-Jin Wu(Tuqiang Foresty Bureau of the Great Xingan Mountains, Tuqiang 165301, China)

The paper reports on the achievement of study on biology, control of Ochropteura finnica Tauscher and the causes of broke-out in 1988. The pest existed in the area is native species of the Great Xing'an Mountains. This paper introduces the biological properties of Ochropteura firnica Tauscher, and describes the method of Controlling. The causes of the breakingout of the insect was elimination of its natural enemy, the parasitic fly burned by disastrous fire in the same year resulting in lose of biological control.

#76
STUDY ON ECOLOGY INJURY BY LARCH CASEBEARER. Enyu Yu (Forestry Institute of Jilin Province, Changchun 130012, China)

Larch casebearer (Coleophora dahurica Flk.) is a dominant defoliator of larch in Northeast China. The period of damage by larvae after overwintering was from the end of April to the second ten days of May in Jilin Province. The length of needles fed by a larva was 143.3±16.96 mm (individual) and 142. 4±5.08 mm (group one), which is equal to 12. 7±1. 48 needles and 12.5±0.46 needles according by $\sum_{i=1}^{n}$(Xi/Li), where Xi : length of needles fed by a larva in i stage, Li: length of needle at same time. The number of needles damaged by a larva was 35. 4±1. 18 needles (group); beging equal to length of needles was 418. 6±46. 95 mm (individual) and 424.2±13.37 mm (group). Under condition of middle or lower population density, level by damage on different position of crown: upper- (47.8%) > middle-(26. 9%)≈ lower-(25. 3%) storey crown; top-shoot (61. 0%) > branchyblaste (30.2%)>branchlet (8.8%). The larch has a rather powerful compensation that after defoliation. It has been shown that the compensatory rate of the needles damaged by larch casebearer for one month was over 20%: the needles of a whole lost damaged by pest was over 74%, but the surviving needle was 42. 6% , and needle biomass was relatively poor where lower-storey of crown in May.

#77
STUDY ON THE SELECTION OF POPLAR RESISTANCE TO CRYPTORRHYNCHUS LAPATHI. Rui-tong Gao, Zi-xiang Yang (The Research Institute of Forestry CAF, Beijing 100091, China)

In artificial seedling growth of poplar, Cryptorrhynchus lapathi is a serious insect pest. Study was conducted in the plantation, where the damaged plant rate was over 80%.The aim was to select fine trees which were mainly resistance to C. lapathi and combined with the comprehensive target of fast-growing and high-yield. In laboratory and in the field artificial inoculation and natural infection were carried out for the 3-year old fine trees. The results showed that the resistance of No.106 fine tree was much more than control species and the all fine trees.According to that analysis of its bark, it's preliminariry considered that the resistance of the tree was related to the amount of fructose and phenolic acid.

#78
A STUDY ON THE CONTROL INDEXES OF CRYPTORRHYNCHUS LAPATHI L. Runsheng Zhang, Feng Tian, Xianghong Bi, Shuping Gou, Jiamei Shun (Forestry Protection Institute of Heilongjiang Province, Harbin 150040, China)

Cryptorrhynchus lapathi is one of the quarantine species of poplar pests. In order to control its population density under the critical levels, a strategy for the combination of TPM and IPM should be carried out. From the point of view of total population management (TPM), the control of this pest are listed in table 1.

Table 1 Indexes of the TPM

Attacked percentage (%)	Average population Density (heads/tree)	Control methods
<5%	0.2	Biological control
5-10%	0.5	Chemical or biological control
10%	>1	Chemical control must be carried out and attacked trees be removed and burnt

#79

A STUDY ON THE RESISTANCE OF PHENOLIC AND ACIDIC SUBSTANCES IN POPLAR BARK TO CRYPTORRHYNCHUS LAPATHI L. Jingquan Liu (Northeast Forestry University, Harbin 150040, China) Yuntai Qi, Guoming Chen, Wenjun Fu (Shanghai Institute of Entomology, Academia sinica)

Phenolic and acidic substances in bark of eight species of poplar were analyzed by using HPLC. These included catechol, P-hydroxybenzoic acid, vanillic acid, eugenol acid, syingic acid, p-coumaric acid, ferulic acid. Among these chemical substances, only catechol content was found having a certain relation to poplar's pest-resistance. When the catechol content was above 0.023mg/g (dry bark weight), the damage caused by the pest was neglighible, and such trees were considered as pest-resistant species, e. g., P. koreana, P. pachydermis, P. xiaohei Hwang CV-14, and the catechol content was below 0.022mg/g, some species, e. g., P. berolinesis, P. euramericana (Dode) Guimer CV. 'sacreu 79', P. russkii, P. euramericana were subject to be seriously affected and trees were infective strain. There was an inerrelation between insect resistance and the catechol content in poplar bark, but plant resistance to insect attack was the result influenced by many factors.

#80

APPROACH TO FORECASTING TECHNIQUE FOR OCCURING QUANTITY OF OSIER WEEVIL CRYPTORRHYNCHVS LAPATHI. Yinyue Hu, Kuanyue Liu, Huahao Chen,. Xueke Zhang (Forestry Department of Northeast Forestry University. Harbin 150040, China)

According to the damage percentage made by the pest on poplars with different ages, the models forecasting damage behaviour have been set up with two methods. First, based on the trend of time-damage percentage in coordinate, cubical hyperbola is drawn up with polynomial regression. Damage percent age of forecasting given by the model accord with the precision, the internal estimated of each time point (age of stand) of damage percentage is y± 0.40. The second is Grey GM (1,1) model, in which the damages, costed by the pest on the poplars with different ages affected by random disturbing factors are expressed as time sequence. the value of each time point in the sequence is forecasted with damage percentage. The model can make a precise forecast for not much longer sequence, and polynomial regression is better than the latter at forecasting the damage in a longer sequence.

#81

THE ISOLATION AND CONTROL EFFECT OF CRYPTORRHYNCHUS LAPATHI L. PATHOGENIC FUNGUS AND NEMATODE. Aiju Hou, Jingquan Liu, Erman Liu, Shengjun Man (Northeast Forestry University, Harbin 150040, China)

Osier weevils (Cryptorrhynchus lapathi L.) are cryptical insect except their adult stage. The C. lapathi pathogenic fungus-Acremonium sp. was found during the study on biological control against Osier weevils. The shape of Acremonium sp. was described and the optimum medium was determined. After inoculation of the pathogen, mortality of osier weevil reached 77. 8% in laboratory condition, and 89.5% in the field. Meanwhile Steinernema sp. was isolated from infected larva. Mortality obtained from the indoor experiment by inculation the larvae was 100% and 89. 5% in the field. This species Steinernema sp. had higher infectivity then S. bibionis Otio, S. feltiae All, S. feltiae Mexican and S. feltiae Agriotos.

#82

STUDIES ON CONTROL CRYPTORRHYNCHUS LAPATHI WITH POISONLESS PASTE. Shuhuai Liu (Station of Forest Disease and Pest Control and Quarantine of Jinsi City, Liaoning 121500, China)

Cryptorrhynchus lapathi is an important borer endangering poplar in Liaoning Province of China, especially in Jinxi district of the Province. The area endangered is increasing year by year. For control the pest, we carried on many experiments with poisonless paste in large area from 1985 to 1986. The effect is above 94 percent. We found that poisonless paste is advantageous to make borer heal up and it is able to promote the tree growing. The optimum period using poisonless paste to control Cryptorrhynchus lapathi is in the last ten days of June to the first ten days of July. Poisonless paste is safe because it doesn't pollute environment.

#83

STUDIES ON HORIZONTAL DISPERSION OF HEMIBERLESIA PITYSOPHILA TAKAGI. Ji-wen Chen (Station of Forest Pest Control and Quarantine, Bureau of Forestry, Huizhou, Guangdong 516001, China)

From 1986 to 1987, the stiking slide glasses were used to study the horizontal dispersive distance of H. pitysophila in Huixhou city. The results showed new-born nymphes could be captured within 6000 metres outside the edge of forest, males were whthin 5000m, females, 200m. This indicated that the youngest nymphes, males and females of this species were moved mainly by the air which is as their carrier.

#84

APPLICATION OF 25% BEUCOPHENEL UREA TO CONTROL DENDROLIMUS PUNCTATUS. Ji-wen Chen (Station of Forest pest Control and Quarantine, Bureau of Forestry, Huizhou, Guangdong 516001, China)

From February to July in 1991 25% 1-(0-chlorobenzoyl) -3-(4-chlorophenyl) urea, which made in Star-Fire Chemical Limited Company in Shenzhen, Guangdong, was used to control V and VI overwintering instars of D. punctatus, 450-900g/hectare chemical dissolved in about 19. 5 kg water was sprayed, the control efficiency was 52. 06-76. 90% after 21 days; 300g/hectare and 150g/hectare chemical were dissolved in 10-19. 5 kg water to control the III.to IV instars at first and second generation respectively, the average efficiency was above 79.91%, the percentage of leaf-preserving was over 80%, the density of next generatin could be held below economical threshold.

#85
STUDIES ON THE MULTIPLE OBJECTIVE DECISION FOR DENDROLIMUS SPECTABILIS CONTROL. Xiu-jun Wcn, Zhenliang Wang(Hebei Forestry Rcsearch Institute, Shijiazhuang 050061, China)Zhan-shan Ma(Bcijing Forcstry University, Bcijing 100080, China)

At present, forest pest control decision is based on economic threshold. But in the method of pest control decision economic factor was only considered as basis of pest control decision, the diffcrent control methods were considcred as same, the difference among different control methods were ncglected, and the sequelae of defferent control methods effect on growth dynamic of the forest and the pest insect population, ecological effect, social effect cct. all of these were not considered. And the method can only dccide that thc pest will be control or not, but cannot dccidc that when the pest will be controlled and which method is the bcst control tactics. In this paper. the population dynamics and capacity for eating of Dendrolimus spectabilis, cstimating and valuing D. spectabilis impact for Pinus tabulaeformis and the economic, ecological, social effect of different control countcrmeasure for insect on the forest ect. werc all studied with systems analysis. And then multiple objective decision for D. spectabilis control which decided objectives included six factors that were economic effect, rate of pest controlling, spced of killing insect, economic sequelae of pest controlling, ecological effect, and social effect have bcen suggcsted by multiple objective dccision theory. By which, the best tactics for control D. spectabilis will be dccided.

#86
THE TECHNICAL REGULATION OF BLOCK METHOD CONTROLING PINE CATERPILLARS. Xi-hua Zhou ,Hongpu Song, (The Forest Pests and Diseases Control Centcr of Hebei Province Shijiazhuang, 050051, China) Zhanshui Li(The Forest Pests and Diseases Control Center of Chengde) Anhui Liang (The Forest Pests and Diseases Control Center of Tangshan) Yunchao Li, Yisheng Han(The Forest Pests and Diseases Control Center of Qinhuangdao)

For many years in northern provinces of china, block method has been used to control tree pests which have the habit of climb up and down trec trunk. But, due to difference of insccticidcs formulation, operating procedure, application time, the control result differ greatly. In order to improve the control work effect, reduce waste, and make block method standardized and scientific, this regulation is made. This regulation stipulate detail for: condition using block method,when and how to use block method, how to make up a prescription, safe producing guide. From this regulation you can know how to use block mcthod pratically. This regulation not only direct how to control thc pine caterpiliars (Dendrolimus tabulaefomis, D. spectabilis, D. sibiricas) which have the habit of climb up and down the tree trunk, but also can be used as a reference to control other kinds of insects, such as: Lecoma candida which have the habit of climb up and down the tree trunk as well.

#87
CONTROL OF PINE CATERPILARS, DENDROLIMUS TABULAEFORMIS AND D. SPECTABILIS, BY SPRAYING PESTICIDE BAND OF DELTAMETHRIN OR FENVALERATE ON THE BARK SURFACE OF PINE TRUNK. Changyi Song, Zhenyu Li (Beijing Forestry University, Beijing 100083, China), Jiyong Huang (Forest Bureau of Guizhou Province, China)

A method of using Fenvalerate of Deltamethrin to control pine caterpillars, Dendrolimus tabulaeformis & D. spectabilis, is reported. The dilute Deltamethrin of Fenvalerate emulsion or diesel oil solution was sprayed on the bark surface at breast height of pine trunk with a house sprayer. The treated region of pine bark surface is a band in 3 to 5 cm width. Experiments showed that the method was very effective and less harmful to beneficial insects and environment, since it was a local and trace-spraying treatment and many beneficial insects had not yet begun or had stopped their activities when the toxic band was sprayed. The effect of the pesticide band on pine caterpillars may last for 40 days.

#88
EFFECTS OF PINE DEFOLIATION BY PINE CATERPILLAR, DENDROLIMUS TABULAEFORMIS, ON THE VOLUME GROWTH AND CONTENTS OF SUGAR AND STARCH OF PINE TREES. Changyi Song (Bejing Forestry University, Beijing 100083, China)

The invasion of pine caterpillar, Dendrolimus tabulaeformis on pine and the defoliation of pine will influence the photosynthesis of pine needles. In 5 defoliation levels of artificial simulated defoliation experiments and pine forest naturally injured by pine caterpillar, the contents of starch, glucose, sucrose, fructose were determined with Anthrone Colorimetric Analysis (ACA). The ACA analysis results demonstrated that the starch content decreased significantly with the raising of defoliation degree, the decrease was accelerated when the defoliation level exceeded 50%; when the defoliation reached 75-100%, the starch content was 2-3 times less than the control (defoliation level equals to zero). They also showed that the fructose content changed little, the glucose and sucrose content decreased significantly if the defoliation was above 75%, whereas they increased if the defoliation level was below 25%.

The relationships between starch content of pine trunk base and defoliation level, between starch content and pine volume growth were modelled with regression analysis method. It may be expected that this study will have great importance of the assessment of economic injury level and economic threshold of the pine caterpillar.

#89
A PRELIMINARY STUDY ON THE LIFE CYCLE AND HABITS OF ANICETUS CEROPLASTES. Ju-pu Chang(Puyang Institute of Forestry Science, Puyang, Henan 457000, China)

A. ceroplastes was one of the major parasitoids of Ceroplastes japonicus Green. A. ceroplastes occurred 3 generations each year in Henan Province. It overwintered with larval stage in female of the host, and began to move and feed in March of the next year. Adult wasps were not phototactic, but need supplimentary nutrients. Male wasps were not found both in field investigation and laboratory rearing, i.e. it was thelyotoky. Usually, it oviposited 1 egg into each scale insect. The ovipositional duration was 3-4 days, and the average number of eggs per wasp laid was approximately 30. Natural parasitism was usually 1.5-2.5%, the highest was 7.8%.

#91

STUDIES ON THE NICHES OF Dendrolimus punctatus AND IT'S CONTROL TECHNIQUES. Wan-yan Ma, Xi-lin Wang, Zheng-mao Li (Hunan Institute of Forest Science, Changsha 410004, China)

Dendrolimus punctatus Walker characterized by intermittent outbreak. After a thorough investigation and study of niches of the pine caterpillars in lower density years, the author has put forward the theory of primary and secondary niches of D. punctatus and it's control countermeasuer. In the years that the population of D. punctatus is lower and stable, we can hardly find the pests in general pine grove, But in a tract of special niche we can still find some of D. punctatus. Such a tract is the primary niches of D. punctatus. When a climat and other conditions are benificial to the occurence of D. punctatus, it will propagates and scattens fastly and formes several or many tracts with a tremendous population around the primary niche. These tracts are secondary niches. Therefor the best key to the management of D. punctatus is to control it when the population in primary niche start to grow, which will get the effect of controlling a small aera to protect a large one. We, during our research work of many years, also found out that Pinus elliottii grove has become a new niche of D. punctatus. Hence we thought if we planted Slash pine in pure Masson's pine forest in this niche as artifical niche to attract D. punctatus. We can observe the population dynamic and destroy the pests in a suitabl time.

#92

AN INTELLIGENCE PREDICTION SYSTEM FOR PINE CATERPILLAR. Sao-sheng Wen (Shantou Forestry Bureau, Guangdong, China), Xian-qing Xue, Guo-zhong Zhang (Nanjing Forestry University, China), Wen-wei Chen, Biao Lu, Gui-cong Yang (National University of Defence Technology, China)

This paper shows an intelligence prediction system for pine caterpillar (Dendrolmus punctata Walker) built up by using GFKD-DSS decision support system tool. It is both a prediction system and a mangement system. As a prediction system, it consists of consultation system, model forecasting system and pest occurrence report system and can carry out short-term, intermidiate-term and long-term forecasting of pine caterpillar occurrence date, occurrence quantity, occurrence area and risk degree. As a management system, it contains a model manegement system and a database management system and is able to get directly, view, modify and append of delete data in the 50 pest information databases of 11 provinces. It also is capable of printing more than 120 kinds of report table of pest information and pest investigation tables.

This prediction system runs on IBM PC or Great Wall series computers and can be used to forecast pine caterpillar occurrence in all the pine caterpillar occurrence areas of China and manage the information about pine caterpillar prediction.

#93

A STUDY ON THE EFFECT OF THE NEW MODEL INSECT-KILLING CRACKER ON DENDROLIMUS PUNCTATUS. Zhang Keehi (Advisory and Developing Department in Science and Technology, Fujian Agricultural College Fuzhou 350002, China)

The new specialized insect-killing cracker is a patented product of Advisory and Developing Department in Science and Technology, Fujian Agricultural College (no. 90204382 • X, utility model patent, P. R. China). *Dendrolimus punctatus* Walker is one of the most harmful forestry insects in China. It distributs in 13 provinces and districts where pine trees are severely damaged. In June 1989, this insect-killing cracker was applied to pine trees to control *D. punctatus* at various location of Fujian Province. On Yangli forestry farm, the controlling efficiency was over 80%. Minhou Forestry Bureau applied this insect-killing cracker at various elevation. The controlling efficiency of 3260mu pine trees in Xiangqian and Qingko Village (elevation of 110-120m) averaged 70%, while that of 1000mu pine trees in Huoqiao Village (elevation of 650m) was 69.8-80%. This insect-killing cracker was also used to control *D. punctatus* in Guangdong and Jiangxi Provinces. The controlling efficiencies were 90% and 84.1% respectively. The cracker is filled with *Bacillus thuringiensis*, *Beauveria bassiana* and their protoxin as insecticide. The *B. thuringiensis* and *B. bassiana* released from the cracker can build communities in forestry to control *D. punctatus* for a long period.

#94

THE EFFICIENCY OF POISON-CHALK OF DECIS IN PREVENTING RAIN CLEAN. Hong-yang Pan (The General Station of Forest Pest Control, Shenyang 110031, China)

The poison-chalk of Decis is a new form of pesticide, which is the mixture of Decis with gypsum, talcam powder and is formed like chalk. Drawn it on the bark of the tree in circle can kill the pests (such as Dendrolimus tabulaeformlis) when it goes down the trees to the ground for overwintering in autumn and goes up in spring. Sometimes the poison-chalk of Decis is easily cleaned by rain. No. 10 engine oil selected from 7 kinds of rain-proof chemicals was added to the mixture, so the rain-proof chalk was formed. A test of 21.7 mm rainfall was conducted in Pinus tabulaeformis to kill Dendrolimus tabulaeformis, the mortality was 94.7%, meanwhile the mortality in control plots was only 84.6%. Based on the 30 times of the experiments in different rainfall, the model between the rainfall and the mortality of D. tabulaeformis has been set up. $\hat{y}=94.01-1.10x$, $r=0.985$, $f=28$. The linear regression test showed that the reliability was 0.999, so the model could be used for forecasting the efficiency of D.tabulaeformis in advance of 30-40 days.

#95

THE SCIENTIFIC MANAGEMENT SYSTEMATIC PROJECT OF DENDROLIMUS SUPERANS IN SHANGZHI CITY. Xuanji Liu, Jinglin Huang, Weisheng Wang (Forestry Disease and Pest Control and Quarantine Station, Shangzhi City, Heilongjiang 150622, China)

This. paper deals with population dynamic system of Dendrolimus superans L. and relationship among the forestry, meteorological elements, natural enemies and D. superans. The prediction method was studied and the occurring area of D. superans was scientifically and reasonably divided into districts such as frequently damaged districts, occasionally and no damaged districts. The management flow diagram of this pest was drawn up and micro-computer management and strategic decision making system was set up.

The main technique indexes of this systematic project are as follows:

1. predictive models

(1) Percent predictive indexes only: predictive index is 49%, more than 49% the damage caused by Dendrolimus superans is serious, otherwise the damage is not serious.

(2) Polyregression dynamic prediction model is (predict the state in 4 years)

$$\hat{y}=9.54+0.014x_1+0.16x_2-0.159x_3-0.154x_4-0.271x_5-0.899x_6$$

2. Control index

For artificial larch stand, when the half of the leaves were lost, the lost volume of timber is about 1.31m/ha. The control index of Dendrolimus superans is: average population density 44 heads/tree (20 years old larch).

#96

A STUDY ON THE ELECTROPHORETIC GENOME PROFILES OF THE CHINESE STRAINS OF DENDROLIMUS CYTOPLASMIC POLYHEDROSIS VIRUSES. Liang Tao, Chang-jie Chen, Zhi-xian Wang and Jia-wen Chen (Division of Entomology, Forest Research Institute, Chinese Academy of Forestry, Wan Shou Shan, Beijing, 100091, China)

This paper investigates the genome profiles of the Chinese strains of Dendrolimus cytoplasmic polyhedrosis viruses (DCPVs) which is one of the most effective means in integrated management of Dendrolimus spp.. The genomes of DCPVs were examined in 3% disc PAGE system which was not only suitable for classification, but also effective to detect the intra-type variations if the gel was stained with ethidium bromide. Based on the electrophoretic patterns of genomic dsRNA, it can be concluded that there were three genomic types of DCPVs infecting the larvae of Dendrolimus spp. in China, and any possible combinations of the three types of DCPVs could mixedly infect the pest. It has been found that possible latent CPVs were induced in the larvae of Debdrolimus punctatus or Heliothis armigera by inoculating DCPVs, this finding indicates that some larvae which look healthy in lab or in Nature might have been latently infected with CPV. Another finding is that the molar proportions of RNA segments in genome profiles of some mixed CPVs were always stable, this implies that these mixtures of CPVs might have a solid-relationship, therefore it could be hypothesized that some mixed CPVs were symbitic during their replications. These findings suggest that the further research into latent and mixed CPV-infections be worthwhile.

#97

PRELIMINARY EXPERIMENT OF CONTROLLING AMBROSTOMA QUADRIIMPRESSUM MOTSCH. BY USING STICKY RINGS. Ming-xu Liu, Wei Liu, Wen-chang Gu, Gong-tang Shao (Station of Forest Pest Control and Quarantine, Lanxi, Heilongjiang 150001, China)

A. quadriimpressum is a main defoliator of elm. It can cause heavy damage. This paper studied on the method using sticky rings to control pest, based on the biology of A. quadriimpressum. In the spring (in the late of March, Heilongjiang) before the pest scrambling up trees, a 5cm wide plastic ring was fixed on the stem 0.5 metres above the ground grasses, then 2-3g nontoxic sticky matter (oligomeric polyisobutylene mixed with compressed polyproylene) was smeared on the ring, this purpose was to prevent pest climbing up trees. After the method was used, environment was not polluted and natural enemies not affected, and the density of pests could be kept below 5/tree, the cost of control per mu decreased 20% compared with the check in which the chemicals was used. If this method is adopted in two years, A. quadriimpressum can be controlled completely.

#98

STUDIES ON SURVEYING FOR OCCURRENT SITES AND CONTROLLING STRATEGY OF DENDROLIMUS SUPERANS (BUTLER) IN NORTHEAST CHINA. Ke-zheng Li (Forestry Department, Heilongjiang 150001, China), Yong-zhi Yu(Forestry Bureau, Mudanjiang), An Sun (Forestry Section, Mudanjiang)

D. superans occurred periodically, which is closely related with some conditions of forest structures an occurrent sites such as :1 the areas of pure larix stand over 13.3 hectares; 2. the age of larix beyond 15 years, canopy density higher than 0.7; 3. the middle and top of hill. When D. superans was in the reproductive stage, its occurrent areas was only 7. 1% of total forest. The methods to control this pest were: improving forest ecology; migrating spiders artificially; making the pest population under the lowest density threshold by using chemicals; cultivating forest on sealed-hill, constructing mixed forest and taking precautions against the former occurrent sites of D. superans. From 1988 to 1990, the controlling methods were widely applied throughout the province.

#99

TECHNIQUES FOR APPLICATION OF SEX PHEROMONE TO CONTROL PARANTHRENE TABANIFORMIS ROTT.. Ke-zheng Li, Shu-quan Zhao, Liang Zou (Station of Forest Pest Control and Quarantine, Heilongjiang 150001, China)

1. Materials: The natural rubbers were dipped into the E-3/Z-13-octadecadienol until each rubber had 400 μg sex pheromone, oligomeric polyisobutylene and compressed polypropylene were used as sticky matter and synergist respectively. 2.Techniques: From June to August each year, in the areas which the percentage of infested trees was below 10%, 20 g sticky matter was smeared on the stem of the tree towards the sun at 1.3-1.5 meters above the ground, the sticky area was about 225 cm, a rubber was fixed in the centre of the sticky area. This was done once per ten days for four times. In the commercial forest the rubbers were set in a chessboard style at a density of one rubber per 5 mu. For the protective forests of agricultural fields and roads, the rubbers were linearly arranged at a 150-200 m interval. 3. Applied efficiencey: From 1986 to 1990, the above method was used to control P. tabaniformis in 23 cities and counties, the accumulated control area was 393,000 hectares, the percentage of infested trees decreased from 7.35% to 0.5%. This method can save the cost of chemical control, guarantee the quality of the seedlings and avoid the loss of wood production.

#100

STUDIES ON CONTROLLING METHODS OF SPHECIA SININGENSIS HSU. Jinqing Yan (Taiyuan Forestry Bureau, Shanxi 030012, China)

S. siningensis is the important pest on poplar in the flatlands of Shanxi province. The pest has two generations a year, adults emerge from August to September. Illumination and temperature affect its emerging, flying and laying eggs. Newly-emerged adults could be easily captured. The female can be strongly attracted by sexual hormone. The measures to prevent this pest were: 1. Fumigating pieces of toxic wood to kill larvae; 2. Planting new and pest-resistant varieties; 3. Spraying Fenitrothion on the bottom of stems at larva-hatching stage; 4. Capturing newly-emerged adults by hands; 5. Using high voltage net to kill adults; 6. Putting soil on the bottom of trees to prevent adult emerging; 7. Controlling adutt laying eggs by painting white material on the bottom of stems; 8. Strengthening quarantining. Above measures were used in Shanxi province, the significant control efficiency was gained.

#101

SYSTEMATIC MANAGEMENT OF POPLAR STEM BORERS. Fuwei Wang, Yanzhang Niu, Hongyan Zhang (Forest Research Institute of Jilin Province, Jilin 130012, China)

Poplar stem borers occure 0.1 million ha. in Jilin province each year. The injuries of the pests have threatened growth of poplar artificial forest. Management of the pests is systematic engineering. It runs through the whole process of forest management. Systematic pest management includes preventive and control strategy. There are different ideas about time and space. The paper has dealt with the species, forming 3 communities in the special environment and its succession of the poplar stem borers in the west of Jilin Province. It has proposed a series of strategies for improving and administering ecosystem of poplar artificial forest to prevent and control the pests and introduced sampling methods of the pests.

#102

PEST SPECIES OF CAMPHOR TREES AND THEIR CONTROL. Guang-pu Shen (Forestry Department,Jiangxi Agricultural University, Nanchang, Jiangxi, 330045, China)

199 pest species of Camphor Trees, belonging to 55 families, 9 orders, have been known by on-the-spot investigating and looking up reference materials for recent 6-7 years.

The major pest species vary with the growth stages of Camphor tree. In nurseries or below 5-year-old stands. *Moricella rufonota* Rhower, Occuring during April to June, and *Orthaga achatina* Butler, Occuring during July to september. Above 10-year-old stands, the major pests are *Orthaga achatina* Butler, Some species of *Limacodids, Psychids, Saturniids, Cerambycids, Curculionids* and sucking mouthports species, such as *Coccids, Psyllids, Aleyrodids, Termites* and *Tetranychids*. Giant and ancient camphor Trees are injured manily by *Termites* besides the pests mentioned above. Especilly *Coptotermes formosamus* Shiraki.

Since those major pests injure camphor trees and affect their growth more or less in different site types. it is necessary to control them, As a rule. Spraying Stomach poisons to control leaf-eating pests is much effective it is done at suitable time, While for controling sucking or boring pests. systemic insecticide are applied. The best method is root-spraying. Which is safe and has long-term effect.

#103

OVIPOSITION BEHAVIOR OF Anastatus japonicus Ashmead (Hym.Eupelmiade).

Wen-xue Wang (Central-South Forestry College,Zhuzhou,Hunan, 412006 , China)

Oviposition behavior by mated wasp of A. japonicus on Antheraea perni Guerin (Lep.Saturnidae) and Dendrolimus punctatus (Lep.Lasiocampidae), can be devided into five components: 1. Examination.the antennae drums on host surface while standing on it, the duration on the former (the same below) was 0.58±0.18 min..2. Drilling. Femal drills through host chorin by rotating the ovipositor alternatively clockwise and counter clockwise,the duration 9.16±9.40 min..3.Stir-feeding-stir.Stir the egg contents with ovipositor accompanied by right and left biase of the body,withdrow ovipositor out and suck up the fluid. drilling again. the duration was 11.70±6.12 min..4. Relaxation the duration was 0.58±0.41 min..5. Oviposition with the strong constriction of the abdomen one egg was inserted, the duration 1.53±0.71 min.. Only a few wasp lay egg at the end of relaxation.No behavior difference was notced between mated and unmated femal as well as that between laying male and female egg. The kairomone for drilling primarly come from host chorin, and that for oviposition come from host contents.

#104

A STUDY ON BIOLOGY AND CONTROL OF MEGABLESES LIRIODENDROVORAX XIAO.

Gui-ming OuYang, Wei-He Huang (Pingxiang Scientific and Technological Association, Jiangxi 337000, China) Yang-xiao Ping (The Institute of PingXiang Forest Science. Jiangxi 337034. China)

Megabeleses liriodendrovorax Xiao is a serious pest of Liriodendron Chinense (Hemsl) Sary. It occurs one generation per year in Tonggu and Pingxiang of Jiangxi Province, China. It changes prepupa over winter in soil cell in the old developed larva stage, and turns to pupa beginning in the first ten days in April next year. The adults emerge beginning from the second ten days in April, and larvae emerge from the frist ten days in May. After 23 days, the larvae begin down to the soil and overwintering. This pest occurs generally in the pure forest, and the larvae were of ten killed by wasps. By using DDVP 1:1000-1500, Monocrotophos 1: 1500-2000. or Methamidophos 1:1500-2000. the control effect is over 90 percent.

#105

STUDY OF CONTROLLING BAMBOO LOCUSTS BY RED-HEADED BLISTER BEETLES.

Zhang-Taizhou, (Forestry Bureau of Jingan County, Jingxi Province, 330600, China)

Red-Headed Blister Beetle's larva are able to eat egg masses of Bamboo locusts. They are the natural enemy of Bamboo Locusts. Their adults like to eat leaves of paulownia. It is a rather ideal biological way of controlling Bamboo Locusts to propagate a great number of Red-Headed Blister Beetles by plant Paulownias where Bamboo Luests occur. We know that Red-Headed Blister Beetles, which eat eggs of Bamboo Locusts, There are two species of red-headed Blister beettes-one is *Epicauta Ruficeps Illiger*, the other is *Denierella Serrata Kaszab*. They almost have the same bionomics. The place where Bamboo Locust adults lay eggs, the Red-Headed Blister Beetles adults lay eggs too. when Bamboo Locust adults lay eggs, the first-instar larva come out of the earth and look for eggs of Bamboo Locusts, and to eat it, one larvae is able to eat up a piece of Bamboo Locusts egg mass. Paulownias are fited to plant at the foot of the hill where bamboo grow, such as in the open places, in the forest and along the roads there are fuul of sunlight. The proportion of the area of the groves of bamboo to the number of the planted paulownias is 10 to 2. Paulownias can lure a great many of Red-Headed Blister Beetles in three years after they are planted. and in 4 or 5 years the occuring of Bamboo Locusts will be under contril.

#106

STUDY ON THE MODEL OF CONTROL INDEX FOR COLEOPHORA DAHURICA FIKV.

Liyuan Jin (Yichun Academy of Forestry Sciences, Heilongjiang 153000, China)

At present, there are a lot of information on the pest control index in agriculture and forestry, but in the reports about study on the control index of larch casebearer (Coleophora dahurica), the writer only found the index for using once, the control index model for long-term use has not been found. The writer conducted further survey and did measurements and statistics on the average weight per needle and the average weight of the needles per shoot in unit length, as well as the average needle number per cluster based on the previous studies on the measurements of needle weight in different larch stand, the effect of needle losing amount on volume losing amount, and the measurements of feeding amount by larch casebearer. According to 6 direct parameters and 6 related indirect parameters, the control index, model of this pest was developed as follows:

$$Et=[(c/p)/a]^{b}\div Nx0.01ex0.01D$$

Where, ET:control index (number/m), C: total contral cost (yuan/ha), P: timber price (yuan/m), e: efficiency of control method (%), D: percentage of damaged trees (%), N: standard numbers of shoots per tree, a, b: power-law regression coefficient of the maximum carrying capacity for the insect per tree (number/tree) related with volume losing amount (m/ha) . There are two formula for the model in calculating spring control index and whole year control index. It is not necessary to think over the different stand density and damage days in applying.

#107

TRANSPLANT OF ANASTATUS SP. AN EGG PARASITOID OF THE TESSARATOMA PAPILLOSA FROM GUANGTONG TO CONTROL THE DENDROLIMUS TABULAEFORMIS AND D. SPECTABILIS.

Hua-sheng Chen, et al. (Beijing Forestry University. Beijing 100083, China)

Since 1984, we carried out the transptant experiment of Anastatus sp. from GuangDong province to North China for the control of the Pine caterpillars. Dendrolimus tabulaeformis and D. spectabilis, and the local popuiation of Anastatus sp. was also used in the experiment through laboratory artificial reproduction. It is found that the offspring per female of the transplanted population is 238.7 and the local population only reproduce 209. In addition the 92 percent of the transplanted population individuals finish their development within 32 days, but that of the local population only 66 percent. In 1984 and 1985 the forest release experiments of the wasps for control of the pine caterpillars were performed in Miyong county of Beijing, the parasitism of pine caterpillar of transplanted population is 4 to 5 times than that of local population (transplanted 23.77%, local 5.34%) and the naturat parasitism of control field is 1.4% from 1986 to 1989, in Qinghuangdao of Hebei province, the release experiment showes that the parasitism of transplanted population is 7 times that of local population. From the experiments, we consider that the transplant of Anastatus sp. from Guangtong to North China for the control of pine caterpillars seems to be a promising tactic.

#108

BIOLOGY AND CONTROL OF CEPHALCIA YANQINGENESIS XIAO (HYMENOPTERA: PAMPHILIIDAE).

Zun-lou Zhang (Beijing Forest Bureau, Beijing 100029, China)

Cephalcia yanqingensis Xiao is a pest of Pinus tablàeformis Garr. which was found in Yanqing County of Beijing Municipality in the 1980's. They can eat out all the needles of a tree when it occurs enormously. Biological studies were carried out in Yanqing County and results showed.

C. yanqingensis occurs one generation a year, overwintering underground in the form of full-grown larvae from early August. Pupae appear from the first ten days of the following May. The duration of pupal stage is 11 to 20 days. Larvae have 5 stages, with the duration of 1-4 instars 15.1, 13.5, 9.8 and 8.4 days, respectively. The adult can live for 14-18 days, with a sex ratio of 1:1.25. One larva will eat 16.3 needles during its life time. Controlling methods: Using dichlorvos-malathion aerosa during the heydays of the adult stage. Spraying 50% phoxim (1000x) at the larval stage can kill 98% of the larvae of the sawfly.

#109

AFFECTION OF DIFLUBENZURON III ON FEEDING AMOUNT OF DENDROLIMUS TABULAEFORMIS LARVAE. Zhi-ming Zhang(Beijing Forestry Protection Station, Beijing, China)

Indoor, Dendrolimus tabulaeformis larvae are fed with pine needle treated with Diflubenzuron III at concentration of 500 ppm, 250 ppm, 100 ppm, 50 ppm,25 ppm, 10 ppm and 5 ppm respectively. Regular survey of larvae's faeces amount can reflect the variation of their feeding amount. Results show: after feeding pine needle treated with Diflubenzuron III at higher than 50 ppm, the larvae will decrease obviously faeces amount in 4-12 days. After feeding pine needle treated with Diflubenzuron III at lower then 25 ppm, the larvae will decrease obviously faeces amount in 16-20 days. Results also show that Diflubenzuron III can seriously affect the normal feeding of Dendrolimus tafulaeformis larvae, and it can possiblely be accumulated inside larvae body.

#110

PRELIMENARY STUDIES OF CHOUIOIA CUNEA SP. NOV. Hong-kui Wang,et al(Forestry department of Shenyang Agricultural University,Liaoning China 110161)

In natural enemies of Hyphantria cunea Drury. there is a Chouioia cunea sp. nov. This paper discribes the form properties of C. cunea, and habits and characteristics. Average percentage which C. cunea lives in worm and pupa of H. cunea is 43% (20.6—80%). The population has strong vitality so that can be breeded and used.

#111

DEVELOPING AND USIUG OF POISON BELT WITH PERMETHRIN TO CONTROL PINE MOTH (DENDROLIMUS SPECTABILIS). Shugui Gao, Jinfeng Liu, Peilian Zhao (The Control and Quarantine Station of Forest Diseases and Pests. Jinzou District, Dalian 116100, China)

The research is used to control pine moth climbing up trees in early spring with poison belt, which is made with Dicis pesticide and plastic film. It had been developed and tested from 1982 to 1990, and had been successfully used in 15,686 ha pine forest. The everage effective rate was 97%, and the time of efficacy was 33 dyas. Each hectare only costs 1.5 Chinese yuan. The time of effciency will delay for many years as the prevention and cring occured. It's very easy to make and use, and no harm to human beings and animals, economical and effective. It can also control many kinds of injurious insects that have the habits and characteristics of up and down trees. Now this was appraised to be a best method by internal experts, had gained province Government Award in 1989.

#112

PHYSICOCHEMICAL CHARACTERISTICS AND BIOLOGICAL ACTIVITIES OF CPV OF PARASA SINICA MOORE. Xing-heng Zhou, Ling Shen (Nanjing Forestry University, Nanjing 210037, China)

The Ps-CPV polyhedrosis bodies have a shape of regular icosahedron. Its average diameter is 1.2μm, and its polyhedron consists of 16 species of amino acids, in which aspartic and glutamic acids are rech, but cysteine and methionine are poor, the ratio between alkaline amino and acid amino acids is 0.76. The virions have a mean diameter of 51. 3nm. The result of biassay showes that the LC_{50} value which infected the third instar larvae by Ps-CPV is 1.21×10^5 CPB/ml. The result of cross absorption test and counter immuno electrophores is of several species of viruses indicates that Ps-CPV and brown nettle moth CPV have the same antigenic. The RNA were extracted from Ps-CPV polyhedra purified by means of SDS-thermal phenol treatment, its unwinding temperature (Tm) value is 80. 5℃ . The genome consists of nine (1% agarose gel electrophoresis)or of ten (in 3% polyacrylamide gel electrophoresis) RNA segments, this molecular mass ranges from $0.34\text{-}2.57\times10^6$ with a total of 14.88×10^6.

#113

PRELIMINARILY DISCUSS ABOUT THE GUIDE PRINCIPLE OF BLOCKING AND PUTTING OUT FALL WEBWORM. Kai Qi(Epidemic Prevention Station of Fall Webworm of Liaoning Province 110031, China)

The potiсy of blocking and putting out the Fall Wabworm Hyphantria cunea (Drury) task for every local government given by out government. For decade, our work is distinguished because we have been following out the guide principle. We have got great achievement in controlling endanger, putting off the diffusion,putting out the epidemic, protecting the agriculture and developing the commodity economy. The author thinks the guide principle that taking the different measures in accordance with the situation will make out work to block and put out Fall Webworm better than before.

#114

INTEGRATED MANAGEMENT OF POPLAR PESTS WITH THE GLABROUS SPOTTED WILLOW BORER AS MAIN TARGET IN THE PLAIN AREAS OF MIDDLE CHINA. Wenjie Li, Cunxian Wu (Anhui Forestry Institute, Hefi 230031, China), Jinzhong sin (Henan Forestry Institute, Zhengznou 450002, China)

The program of the Integrated Pest Management (IPM) of poplar longicorn is different from those of IPM for defoliators. The former has no concept of the philosophy of tolerance, that is, no permission for a certain amount of the insects to present. The idea of the management is to get rid of the insect fountainhead, enhance the quarantine, select good varieties for afforestation, plant separation belts and bait trees and use both chemical and manual methods to timely kill the insect. When a forest stand is in the middle to postmiddle-aged stage, it is necessary not to use chemical but biological control to regulate it artificially. During the management, a treatment must be done respectively according to different stages of insects and stand.

#115

A STUDY ON THE FOREST-ECOLOGICAL CONTROL OF *ANOPLOPHORA GLABRIPENNIS MOTSCH.* Sun Jinzhong, zhao Zhongyi, Qian Zhenguo,Liu Fenluan,Ru Taoqin (Forest Research Institute of Henan Province,Zhengzhou 450002,China)

The authors conducted experiments of 4 years (1987-1990) based on the ecological managements of the tree components in the popular forest to control the *Anoplophora glabripennis* and very good results were obtained. By planting *Acer negudo L.*(very attractive to *A. glabripennis* for feeding,copulating and ovipositing) as trap bands within a sphere of 370m along the borders of the popular forest may reduce the damage done by *A.glabripennis* by 83% or more.The pattern of planting *Acer negudo* should be 30-50m apart as their planting distance.Meanwhile,in the 4-year old popular forest to set up quarantine bands of *M.azedarach L.* (strongly resistant to *A.glabripennis)*,the per cent of damaged tree and the average population density of *A.glabripennis* reduced 91.6-97.4% and 93.7-96.2% respectively. So,the authors suggested that planting quaranfine bands and trap trees is good ecological forest control measures to reduce the damage of *A.glabripennis Motsch.*

#116

STUDY ON THE HOST AND NON-HOST SYSTEM OF APRIONA GERMARI. Jun-jie Yan, Da-zhuang Huang, Zhi-gang Wang, Dian-rong Ji, Ye-huei Yan(Hebei Forestry College, Baoding, 071000 China)

The study on the host and non-host system was carried out in Hebei province in order to approach the planting models to control the demage of the mulberry longicorn(Apriona germari), which is a destructive borer to forest trees, fruit trees and mulberries. Field and indoor experiments showed that the non-host varieties have resistance in varying degrees to the pest, the adults were forced to eat the young bark of the non-host varieties, then died after producing a few eggs. The host varieties were susceptible.37 non-host and 19 host varieties were selected among 56 tree species based on the demage of the adult and the larva. The study also indicated that two grades could be divided among the host varieties, the I grade hosts could be demaged by both the adult and the larva and the II grade hosts only by the larva.

The conclusion was that seperate-planting between host and nonhost varieties could effectively control the demage of Apriona germari on the basis of controlling the sources of the pest and I grade host varieties.

#117

THE STUDY OF INTEGRATED CONTROL OF TREE TRUNK BORERS IN THE PLAIN AGRICULTURE AREA. Zhi-hua Xu(The Forest Pests and Diseases Control Center of Hebei provinee, Shijiazhuang, 050051)

Anoplophora glabripennis Motschulsky, Apriona germari(Hope), Cossus mongolicus Ersohoff, Holcocerus vicarius(Walker) ete. are the main trunk borers of poplars, willows, elms and other trees in the plain agrieulture area of Hebei province. Research has proved that to control these pests we must take integrated control measures in large area, all infested trees inside the eontrol area must be given suitable eontrol measures according to the pest damage level. The eontrol measures include: doing regeneration felling and planting in time, plant resistant varieties, plant mixed forest, set up pest inspect system, destroy pests eggs, larvae and adults in time after the tree seedlings have been planted in the field, taking control measures every year tending trees intensively, safe-guarding beneficial birds, and taking other effective measures. The afore-mentioned integrated measures has been practised on 20,018,000 trees, these trees scatter in 175,500 ha, in jingxian, Gucheng county. The trees infested with borers has descended from 60%(1986) to 4% or below.

#118

STUDY ON THE RESISTANCE OF DEFFERENT POPLAR VARIETIES TO ANOPLOPHORA GLABRIPENNIS. Zhang-yi Zhou, Feng-lan Li, Rui-qin Wang, Jun Wang (Bejing Forestry University, Beijing 100083, China)

Different resistances can be observed in various poplar species to A. glabripennis, the anatomical structure and the nutritive situation have been investigated and compared between the strong resistant poplar species 1-69, 1-72 and the high sensitive species Da guan. The feeding test of the larvae of A. glabripennis has been done. Experimental results indicated that the sugars and the protein contained in the strong resistant species decreased, we also find a decline of nutritive ratio, an increase of the number of stone cell, a dose arrangement of fibers, a crassitude of cell wall, an increase of cellulose, lignin and ash content, and a decrease of the quantity or absence of glycine, histidine, valine. As the food of A. glabripennis, the quality of these poplar species had been dropped, and there is a obvious decrease in the weight-gain rate of its larvae.

#119

SILVICULTURAL MANAGEMENT OF PINE CATERPILLAR, DENDROLIMUS SPECTABILIS, A DEFOLIATOR OF PINE TREE-INDUCED RESISTANCE OF PINE TO THE PEST (1) . Zhangyi Zhou, Zhizhong Zhang (Beijing Forestry University, Beijing 100083, China)

Taking Pine tabulaeformis as an object, tree growth and physiotogical effect of pest on it were systemetically studied through forestry measures such as mixed forest, closed forest, fertilizer application, defoliation, pruning from 1983 to 1990. The Change of nutritive ratio, coefficient of digestibility, digestive rate, metabolized energy caused by tree physiological condition and their effect on growth and reproduction of dendrolimus were also studied.

The major storage untrition of P. tabulaeformis is fat, most of which is stored in neddles. Digestine rate of protein is higher when dendrolimus is in its young stage, while degistive rate of fat turns to be higher as the pest grows elder, But metabolized energy of fat is higher than that of protein in both stages. Silvicultural practices could help reduce nutritive ratio, coefficient of digestibility and metabolized energy of Dendrolimus, and lower its development speed, weight and reproduction capacity might include establishing mixed forest or closing forest area from human activities. Nutritive effect is an important factor to avoiding outbreak of Dendrolimus. It should not be ignored. The effect of nutrition on larvae of dendrolimus of dark colour type is stronger than that of light ones.

#120

A STUDY ON Pristiphora erichsonii. Li Hueichen (Forest Protection Station of Wumen Prefecture, Inner Mongolia 010000, China)

An investigation was made on forecasting, control index and control methods of Pristiphora erichsonii in Wulanchabu Prefecture of Inner Mongolia Autonomous Region. Main findings are as follows: 1, Forecasting: using development rate and effective temperature rule to forecast the occurance period of larch sawfly. The optimum control period for larvae is when the second instar larvae occupy 50% or third instar larvae occupy 15% in the insect population. Using effective number of the pests in last generation to forecast the larvae's population density. 2, Control index: if the average height of the trees is 3.5m, the control index is 139 live cocoon per tree when investigating in autumn and is 45 live cocoons per tree or 21 eggs per sample branch or 11.7 second to third instar larvae per sample branch when investigating in summer and spring. The economic threshold level of damage is 40% defoliage rate. 3, Control method: when the canopy density is adove 0.6, smog pesticide is used to control the second to third larvae. When the population density of the pest is high and the vegetation under forest canopy is little, Litters was removed and cocoons were exposed to light in autumn. When the population density of the larch sawfly is low, Nest boxes hanging on larch were used. Chemical control to the larvae shousd be conducted in the period of second to third instar.

#121

PROBE INTO CONTROL STANDARDS OF THE LARCH SAWFLY. Tao Boer, Wang Kewei, Li Yabai (Inner Mongolia Academy of Forest Sciences, Huhehot 010010, China)

In 1986-1989, the control standards of larch sawfly (Pristiphora erichsonii) in artificial larch forest were probed in Wlanchadu Prefecture of Inner Mongolia. It was found that the economic thresholds-mold used in agricultural pest could not well applied in larch sawfly control practice. The problem of control standard against larch sawfly should be probed and the conception, definition and mold of control threshold which can reflect the future and law of the forest system were put forward. This definition was based on the contradictory relationship of forest and pest biologically and ecologically, but not only on the economic point. The leaf-lost intensity, leaf-lost year and forest growth lost rate quantity; forest age and leaf quantity; sawfly leaf-eatting quantity, egg quantity, survival rate of larva during the period of leaf-eatting; developmental durations of egg and larva; the damage years and the over-winter mortalities were carried out by the basis of the control threshold to meet the needs of practical production. An experimental patterns of scientific control standard which based on the over-winter cocoon numbers and the densities of eggs and larvae duing the period of leaf-eatting have been established. The results were a profitable try for probing the scientific control standard and pattern of forest leaf-biting pests.

#122

STUDIES ON THE COCCOIDEA AND THEIR NATURAL ENEMIES IN NINGXIA. Jian-yi Wang (A: Forestry Research Institute of Ningxia Agri-Forestry Academy, Yinchuan 750004, China), Xi-meng Wang(Ningxia Agricultural College, Yongning 750105, China), Hua Tang(A),et al.

A research work of " Studies on the Coccoidea and their Natural Enemies in Ningxia " has been conducted since 1982. The biological charcters of disastrous coccoidea and the biological characters and protection & utilization measures of 10 species of dominant natural enemies were described. The spacial distribution pattern & sequential sampling of 6 species of disastrous coccoidea were reported and used in pest forecast. Vegetative chemicals and mineral chemicals that were more effective to the pests and less toxicant to the natural enemies were selected. Six aspects of integrated control were proposed. Finally, the effect of coccoidea control in a large area of Yinchuan were summarized. Enclosured are a list of coccoidea in Ningxia (125 species in 50 genera of 8 families, including 1 new genera and 4 new species and tens of species of Chinese new record) and a list of the natural enemies (39 species in 14 families of 8 orders).

#123

THE CHARACTERISTICS OF FOREST INSECTS IN XINJIANG. Wen-liang Ma (Xinjiang Academy of Forestry, 830063, Urumqi, China)

1.Because of the harsh climate and large biotic forbidden zones, the number of insect species in Xinjiang is less than in other provinces. Some areas here are special and favourable in natural conditions, so there are some ancient and unusual species. 2.Most of the insects are small, murky grey or brown. Their larvae is covered with obvious hair. Some are apterons. 3.Many of them live hidden by making galls, boring into wood and borrowing under ground. The stagenation and the life period of the insects last a longer time. 4.Due to the alternation of high mountains and arid deserts, the spread of the insects are difficult. And their vertical distributions are evident. 5.The adaptability of most species are strong even in arid, sandstorm, severe cold, extreme heat and such harsh ecological conditions. 6.Natural forests have stronger ability to control pest, where there are few serious obstacles. But sometimes some pests are great in number. Some key pests do break out periodically.

#124

STUDIES ON THE FORCASTING OF Cryptothelea variegata Snellen. Zhen-xue Shi (Station for forest disease & pest control and quarantine of Yunchen prefecture, Yunchen044000, Shanxi, China). Ying Tong, Zhen-wang Miao(Station for forest disease&pest control and quarantine of Shanxi, Taiyuan030012, China).

Cryptothelea variegata Snellen(Lepidoptera: psychicae), damage the trees of Paulownia tomentosa, Robinia pseudoacacia, Platanus acerifolia, Malus pumila and Diospyros kaki. And also damage some crops such as cotton and corn etc. This bagwarm occurs one generation per year. There are 5 instars for larvae, and overwinters as matured larvae on branch of trees, and insides of a bag. The cumulative temperature is 109.36± 15day degrees; the development initial temperature is 13.7±1.2℃; the forcast formula for emergence of adult is N=109.36±15/T-(1.37±1.2). the duration of pupa, adult, egg and 1-3 instar larvae were 14, 12, 19, and 46 days separately. The correlative regression formulas between first peak periodof pupation and mean temperature of late April (X) is Y=50.2663 -2.5132X; the first peak period of emergence (Y) and mean temperature of middle May (X)is Y=115.1414-4.2006X; the peak periodof feeding by 3 instars laevae and mean temperature of early July (X) is Y=89.8078 -2.5173X. The mean temperature of Dec. Nov., Jan., and Feb.(X) can be used as a forcast factor for larval amount of occurence, the formula is Y= -426.2243+215.0616X. Based on 3 years tests, by using methods of duration . different stages, phenology, regression and active cumulative temperature for predicting the occurrence time of bagwarm; as well as by using the method of regression and active basic number of bagwarm for prediction the occurrence amount. The accuracy rate was up to 90%.

#125

A STUDY ON CONTROL, MONITORING AND UTILIZING OF FOREST INSECTS IN THE EASTERN HILLY REGION OF CHINA. Qing-jie Ge(Nanjing Forestry University, Nanjing 210037 China)

According to our investigation, we found that favourable conditions in water distribution and height difference in the district can be used with trap-lamp to form an ecological management and monitoring model of forest pest. Described here is the model of the"Hill-tree-moth-lamp-fish" that we have lately constructed in the region of Jiangning-Lishui, Jiangsu Province.

Results of experiment showed that: a) the moths and their eggs are good forages for the fish as they contain high protein and essential amino acids. b) the marked pine moth (Dendrolimus punctatus Walker) and other phototactic moths can be attracted to the trap-lamp-water from 1,100m away, and the average residual eggs of a female moth is 82. 3. and c) those old problems such as outbreak in the lamped forest and the long-term prediction of emergence size have been solved by using this model.

#126

STUDIES ON THE BIONOMICS OF *EUPROCTIS* SP. AND ITS CONTROL. Gong Qijing, Lin Bangchao (Forestry Committee of Shaxian County, Fujian, China, 365500)

The Lymantriid moth *Euproctis* sp. is a serious pest of *Campthotheca acuminata* Decne. It has six generations per year in Shaxian, Fujian Province. The fourth instar larvae spend the winter inside thin cocoons in fallen leaves or in clumps of weeds. The overwintering larvae begin to feed on the leaves in early March and pupate in mid-March next year. The adult moths begin to appear in early April. Each female deposits 174-409 eggs. The egg stage lasts 4 to 9 days. Five instars are observed in the larval development, but a few of them have six or seven instars. The overwintering larval stage lasts 87 to 108 days and the others last 15 to 34 days. Mature larvae stop feeding two or three days before spinning eocoons and pupate on the underside of the leaf, branch and trunk. The pupal stage lasts 6 to 20 days. The spans of life are 3 to 17 days for adult moths. Our experiments have shown that the following control measures are effective: 1. Spraying 80% DDPV or 90% Dipterex emulsion in concentrations 1:2000 and 2. Dusting Beauveria bassiana powder.

#127

THE BIONOMICS OF *ANASTATUS* SP. AND ITS UTILIZATION FOR THE CONTROL OF *DENDROLIMUS PUNCTATUS* WALKER

Wu Meng-nai, Chen Jun, Zhao Jia-hua (Forest pests and Diseases Control Experiment station, Yongchu, Sichuan 632160 , China)

Anastatus sp. is an important egg parasitoid of masson's pine Caterpillar in Sichuan Province. It can breed 2 to 5 generations in a year. In the temperature of 24°C, one geneation takes 22 to 26 days. The longevity of male adults fed with honey dew is 4-20 days and that of the female is 26-80 days. The total number of offsprings produced by one female is 153 in average with a daily 4.4 eggs. The Oviposition is concentrated within 30 days after emergence. The optimum temperature is 24-28°C and humidity 60-70% R.H. The eggs of *Amheraea pernyi* Guerin-Menville are the preferable host for mass rearing of this parasitoid which can be preserved in forzen condition without afteeting the suitabllity for rearing. The time for releasing the parasitoid in the field is the initiative oviposition stage of *Dendrolimus* punctatus. The number of parasitoid released is decided by the density of pine larva and natural control of Dendrolimus punctatus Walker and number of offsprings produced by Anastatus sp.. The results shows. Anastatus sp. can depress the population of pine caterpillar effectively, with a parasitism of 47.51-65.30%.

#128

STUDIES ON THE REGULATION BUILDING NEST TETERMES. Odontotermes formosanus (shiraki).

Yi-bing Tao (Hengyang Institute of Tetermes Control. Hunan. 421000. China)

To find the tetermes nests and to destory them are one measure to control tetermes.The paper reported the results of investigation to analyse the location of tetermes nests at least 320 nests.There are 6 factors which relate to the tetermes nest building.(1) It is often built in the high place on the level land.(2)They are near the water source. (3) The structure of soil building nest always are deep and close.(4)The soil temperature would be warm and sunshine well.(5) Where food is rich. (6) Near the nest location has both soil and wood.All above factors are not solitary.but cooperated each pther.

#129

A STUDY ON THE FORECAST TECHNIQUE OF PYRRHALTA(GALERUCELLA) AENESCENS FAIRM.

Jin-Shan Qi (Heze Forestry Protection Station, Shandong 274011 China)

Pyrrhalta(Galerucella) aenescens is one of the main forest pests in North and East China,and seriously affect the normal growth of ulm.The forecast technique was studied during 1973-1987.1. Forecast of Occurance Period. Several formulas are established (1).The initial hatching period of the first generation larvae equals the initial laying period of overwintering adults + 12.5 ± 0.8days.(2).The thriving pupating period of the first generation larvae equals the initial laying period of overwintering adults + 38.9 ± 3.3days.(3).The initial hatching period of the second generation larvae equals the initial laying period of the first generation adult + 6.8 ± 1days.(4).The thriving pupating period of the second generation larvae equals the thriving hatching period of the second generation larvae + 12.8 ± 1.5days.2. Forecast of Occurance Number. The occurance number is forecasted according to the effective basic number.The formula is $P=P_0(e\cdot f/(f+m)\cdot(1-M))$. $P_1=172P_0f_1/(f_1+m_1)$, $P_2=47P_0f_2/(f_2+m_2)$. 3. Forecast of Injurious Degree. According to the natural survival rate, leaves consumption of larvae and compensating ability of ulm,by means of the formula $N=\sum XS/(1+A)(\%)$, the results are $N_1=2.0X_1(\%)$, $N_2=1.4X_2(\%)$.

#130

BIOLOGY AND CONTROL OF CLANIA VARIEGATA SNELLEN.

Di FAN, Xinan Wang, Shuzhen Tian (Forestry Research Institute of Shandong Province, Jinan 250014, China)

Clania variegata (Lepidoptera, psychidae) is a polyphagous insect pest which feeds on many arbors even herbs and extensively distributes in large areas of China. Clania variegata is the most important pest damaging the genus Poulownia in Shandong, Henan and Anhui, where most individuals of the pest complete their lifecycle in one year and overwinter by the last instar larvae in bags spinned by themselves (called overwintered generation) . But 10-30% of individuals can complete two generations a year (called nonwintered generation). The larvae from the nonwintered generation neither overwinter safely not finish their life cyle. Next year, the larvae from the wintered generdtion develop into prepupal period from 21 April to 10 June and the adults emerge from the mid-May to mid-June. Each female can oviposit 3000 (in average) up to 7000 eggs. A large numter of the larvae hatch from 21 June to 10 July. After finishing the fifth instar, the larvae are at mature stage and overwinter in closed bags on current year growths of host plants from September to October. The population of Clania variegata is mainly regulated by natural enemies (eg. Nealsomyia quadrimaculata) severe winter and epidemic diseases. The controlling practices include collecting bags, injecting systematic pesticides such as monocrotophos, omethoate or methamidophos into the base of a tree, dispersing dimilin, spraying crude extracts of CvNPV on the crown of trees, sexually attracting male moths using female moths.

#131

THE QUARANTINE AND THE PEST TREATMENT FOR TIMBER IMPORTED FROM RUSSIA,

Hongxi Yu, Guisheng Xu, Chao Zheng, Zhengqi Wang, Dianwen Zhou, Baosheng Yang (Plant and Animal Quarantine Station, Shuifenhe City, Heilongjiang 157300, China)

China has imported timber from Russia for tens years, those timber mainly transported by using trains, trucks and ships. In recent years, the trade between China and Russia increased rapidly. More than 10 tree species including Larix gmelinii, Picea koraiensis, Betula platyphylla et al. are traded, and the quantity of this trade is very large. Up to now, more than 10 quarantine species, such as Ips typographus, have been determined, and the dangerous species have been treated with different methods such as fumigating with methyl bromide. The compensation for the cost of this treatment were asked to Russia. It is suggested that in the custom where the condition is suitable, the quarantine of the timber should be carried out out of our country. All of the contracts of importing timber should include the quarantine of this timber and all the timber imported should have quarantine certification, so that the quarantine and treatment of timber can be carried out scientifically and systematically.

#132

THE RESEARCH ON DESIGNING A HIGH-PRESSURE AND TRUNK-INJECTION MACHINE TO CONTROL FOREST PESTS.

Dan-ren Qin(Station of Forest Plant Quarantine & Pests Control of Xuzhou,Jiangsu Province,China)

The technology of trunk injection with pesticides has many advantages in controlling the pests in forest and fruit trees,because it needn't to spray the diluted pesticides to the crown of high trees.With the extensive research of technologies, such as dropping pesticides into the opened holes at the trunk base,smearing over on trunk face,and spreading pesticides in wrapped ways,has made the trunk injection technology more perfect.a little systimic pesticide can be used to control many kind of pests effectively.In order to resolve the equipment and some related technology problems in applying trunk-injection technology to control forest pests in large-scale,we have designed a high-pressure and trunk-injection machine.Its characters are as follow:driven by hydraulic pressure,oil and pesticide are separted,high-pressure and high-speed,accurate and quantitative,carried conveniently.When the machine is injecting pesticides into a trunk,the pressure is 30 to 80MPa.The equipment has been used to control Anoplophora glabripennis in poplar,the mean height and diameter of poplar are 16m and 18cm,the injection amount is 18ml,to imagos,the mortality is 95%,to larvae before three stadia,the mortality is 87%.One machine can inject 300 to 400 trees a day;To control Insulaspis pineti,during 40 days,the corrected mortality is 93.16%;It can control Asterolacanium cataneae effectively and inject nutrition liquid.It is confirmed that Anoplophora glabripennis has notable alternative to organic phosphorous systimic pesticides; The compatibility of pesticides can notably increase effectiveness;trunk injection can lengthen the period of effectiveness of pesticides.

#133

STUDIES ON SEX PHEROME OF MULBERRY TUSSOCK MOTH EUPROCTIS SIMILIS XANTHOCAMPA AND ITS APPLICATIONS OF SEX-CAPTURED DETECTING AND FORECASTING FOR PEST POPULATION. Pu Guan-qin, H.M.Du, J.P.Mao, S.Y.Zheng (Suzhou Sericulture College, Suzhou 215151, Jiangsu, China), Z.X.Ten, H.Q.Liu, G.Q.Lin, W.S.Zhou (Shanghai Institute of Organic Chemistry Academia Sinica).

A novel constitution of sex pherome, Z-7-octenyl isovalerate is purified and identified from the sex gland Weshings of the mulberry tussock moth Euproctis Similis Xanthocampa by Thin layer and Gas chromatography, and first found in the Lymantriidae.

Our experiments show that the method used in the present paper is simpler and more precise and costs less with traditional one of light-baited traps.

The peak value of sex-captured moth can be used as the index of occurrence stage forecasting for mulberry tussock moth, which solves a difficult problem that whole generation emergence number isn't know previousely in the process of sex-captured detecting and forecasting. Therefore, we estabolishes a formula for sex-captured detecting and forecasting pest population: peak-day of amount of sex-captured moth+two days(early stage of egg-laying)+egg stage for each generation = hatching peak-day of next generation larvae, which can also be used to control the number of mulberry tussock moth.

#134

OCCURRENCE. PREVENTION AND CONTROL OF CRYPTOTHELEA VARIEGATA. Jian-chu Shi, Jia-you Chen (Forestry Institute of Fuyang Prefecture, Fuyang, Anhui 236000, China)

The large bag moth, Cryptothelea variegata, is one of the most serious defoliators of broadleaf trees in North Anhui. It is hard to control the pest below economic injury level for its wide host range. In the present study, root injection with monocrotophos or methamidophos resulted in a mortality of 95% or more. The injection amount and the breast-height diameter of trees were correlated in the following form:

$y=1.550236788\ e^{0.067329752x}$ ($r=0.994459152$) where:

y--- injection amount of the chemicals;

x--- breast-height diameter of infested trees.

A dose table of root injection into paulownia trees was made based on the above formula.

A combination of UV eight trapping and female moth hanging above the eight resulted in better efficacies.

In addition, an effective parasite, Nealsomya quadrimaculata, was revealed for further application.

#135

A STUDY ON THE BIOLOGICAL CONTROL OF BATOCERA HORSFIELDI BY BEAUVARIA BASSIANA. Chang-ren Ru, Yi-cheng Mao (Hubei Forestry School, Wuchang 430200, China)

Batocera horsfieldi Hope is one of the major tree borers on poplar in Hubei province. The biological control program of Batocera horsfieldi by white muscardin fungus (WMF) Beauvaria bassiana was carried out in 1986-1989. The results showed that the desired effect was obtained by powdering WMF powder or injecting WMF liquid at the egesting-pore and emerging-pore or blocking the pore with cotton plug, soaked in WMF liquid. The control effect of WMF high-spore powder (120 billion spores/g with 90% active spore rate) was almost up to 90-100% while the powdering amount got to 4-6mg/pore with micro powder sprayer. The control effect of WMF manufactured powder (10 billion spores/g with 90% active spore rate) was 75-80% while injecting 10ml liquid. It might increase to 80-90% if Decis (0.1%) was available in the liquid (diluted 50-100 times).

#136

A STUDY ON THE CONTROL APRIONA GERMARI(HOPE)USING BAIT TREES. Xian-kai Zhang, Shi-cai Yin(Hunan Institute of Forest Science, CHangsha 410004, China), Yong-Chun Lei(Nanwanhu Farm, Guangzou Army, Yuan Jiang County 413100, Hunan Province, China)

This paper deals with a set of techniques using trees [Morus alba L., Broussonetia kazinoki S. et Z., Broussonetia papyrifera (L.) Vent] as baits to control the adults of Apriona germari (Hope), Which can prevent poplar plantation from being damaged. The methods, simple, economical and easily conducted, can segregate poplar plantation with pest and kill them before oviposition outside the poplar plantation. In the stands sprayed with insecticide there were at most 19 death adults in one clump of bait one day. It costed 0.084 Yuan (RMB)Per mu. The mean Yearly rate of trees injured reduced by 1.89%. THe pest density stabilized with no increase or decrease. But in control stund the average rates of trees damaged and pest density inhanced 31.53% and 1.07 respectively compared with the stands sprayed with insecticide. Aad difference is very significant (statistical analysis).

#137

STUDY ON UTILIZING Scleroderma quani Xiao et Wu TO CONTROL Asias halodendri. Wang Guodong, Tang Mengchang (Academy of Forestry science, Inner Mongolia 010010, China)

Asias halodendri is one of princepal moth stem pest of hippophae rhamnoides. Scleroderma quani xiao et ou is one of main natural enemies of the pest. This paper reports the operating technique of multipling S. quani and the key method of host treaing. Hosts without passing cold storage period gave lower multiplication rate for S. quani (less than 50%). IF the host passed a 1-2 weeks cold storage at 2-7°C, the multiplication rate could reach 90%. The average yield of wasp per test tube was about 40 heads. we examined S. quani's motheaten ability and the seeking ability to host on the H. rhamnoides in order to supply a proof for putting the wasp in forest. An imitating control experiment on timbers was carried out in laboratory. In this experiment, the multiplication rate is higher than 90%. During putting the wasp in the forest field, a number of parameters such as time, method, of putting the wasp, number of the wasps and the suitable controlling period, were measured. It was found that the middle ten days of June to the last ten day of August is a suitable period for putting wasp. The suitable wasp putting time is noon in a day. In controlling insect state experiment, the larva which harmed the side trunk is used as main control target. The ration 1:3 is a suitable ratio of putting wasp quantity to the worm and pest and the control effect reached 84.0-85.7%.

#138

STUDIES ON THE INTEGRATED CONTROL AND BIONOMICS OF BATOCERA HORSFIELDI(HOPE). Shi-quan Zhang(Hebei Forestry College, Baoding 071000, Hebei Province, China)

White-striped longicorn(Batocera horsfieldi Hope) in Hebei province, which is distributed over various counties in the Taihang Mountain area, mainly attack walnut tree(Juglans sp.). It overwinters in the trunk as adult or larvae of various instar, most of which are 2 or 3 instar larvae. After overwintering, the adults begin to emerge and come out of the tunnel in the middle ten days of April, and then complement nutrition. The females mate with males several times and produce 6 to 12 broods. Each brood has 4 to 6 eggs, 12 eggs at most. Having deposited the last brood, the adults continue to feed for 38 to 54 days and then die.

When the larvae mostly hatch in the medium of June, the deposit-groove can be smeared with insecticide so that the larvae, which have not bored into the trunk, are killed. Some experiments with this method show that the insecticides such as 50% fenitrothion or 40% omethoate can achieve good results and reduce the cost. We apply the poisonfumigated sticks to the control of the longicorn, which had never been tried before. When the sticks are precisely inserted into the bored-hole, 100% of the longicorns(the adult or larva) can be killed.

#139

THE APPLICATION OF GREEN MUSCARDINE FUNGUS AGAINST SMALL POPLAR BORER.

Mei-zhen Fan, Chao Guo, Bin Xiao (Department of Forest Protection, Northwest College of Forestry, Yangling Town, Shaanxi Province 712100, China)

A strain of green muscardine fungus Metarrhizium anisopliae (Metschn.) was isolated from small poplar borer Saperda populnea (Linnaeus). The results of bioassay showed high pathogenicity to the 1st instar larvae of this insect with LD_{50} at 103 conidia/mg body weight. The LT_{50} s of 8925, 1785 and 357 conidia/mg were 1.91, 2.93 and 4.75 days, respectively. The virulence order of this fungus to different stages of this insect was 1st instar larvae>pupae>mature larvae. The control efficacies of 2×10^8 conidia/ml sugar solution suspension and 3.75 kg dust/ha treated in hatching peak to active phase of 1st instar larvae were 73.5 and 84.9%, respectively.

#140

INTEGRATED MANAGEMENT OF ANOPLOPHORA GLABRIPENNIS MOTSCH.. Yu-tian Wang, Jinlong Zhao, Junxiu Fan (Forestry Bureau Shanxi 030002, China)

Based on ecological system of agriculture and forestry, the integrated pest management, such as the cultivation of forest, the using of pest-resistant tree species in afforestation, the improving of ecological conditions and the strengthening of human management, were used to prevent the occurrence and damage of this pest. The major strategies were quarantining pests in the protected areas, elimination pests in the new occurrent areas, controlling pests in the light damage areas, combination controlling pests and reforming trees in the middle damage areas, completely reforming forest in the heavy damage areas. In this paper, there was a chart of integrated management system. Some other methods were also introduced: pest sequence sampling, fumigation timber, construction forest mixed by pest-resistant trees to form seperated zone, controlling pest by biological and chemical methods and forecasting model. From 1986 to 1988, the integrated management was used, the density of pests in the control areas decreased from 21.4 to 0.29 per tree, the percentage of trees infested by the pest declined from 89.6% to 5.2%

#141

STUDIES ON POPLAR GROWTH-LOSS CAUSED BY ANOPLOPHORA GLABRIPENNIS MOTSCH.

You-qing Luo, Jing-fang Huang, Jie Qi (Beijing Forestry University, Beijing 100083, China) Zhi-bai Liu, Zeng-san Liu (Fei County, Banhe Forestry Station)

With identical site-type, 3 Ptots of Poplus simonii carr × nigra var. italica which is sensitive to A. glabripennis were planted in 1987, as natural infestation plot, artificial infestation plot and check plot respectively. The whole experimental area naturally separates A. glabripennis source-tree outside by Ban River. First release of A. glabripennis adult in artificial infestation plot was made in July 1988. Density of A. glabripennis and growth of the poplars were recorded each year. When A. glabripennis damages the poplars under the age of 6-years and density of A. glabripennis is under 20 per tree(sum of larvae in 1988-1990) : 1. In comparsion with check plot, volume in artificial infestation plot dropped 36.19 %, biomass dropped 34.93%. 2. Various damage degrees have less affects on the growth of poplar.

#142

A STUDY ON INTEGRATED CONTROLLING HOLCOCERUS INSULARIS STGR OF HAWTHORN.

Xueweng Liu, Junlou Zhang, Zhenyang Wang (Station of Forest Protection, Beijing 100029, China), Shujun Liu(Walnut Experimental Station, Mentougou, Beijing 102300, China)

H. insularis Stgr. is one of the important pests on hawthorn in Beijing suburbs. it has one generation within two years and damages old and fruiting trees. The highest population reached hundreds of pests per tree, which heavily influenced the yield. The integrated control methods were studied. which included: 1. Agricultural measurement, pruning down branches containing pests and blocking up insectholes; 2. Chemical control, using insecticide to fill up insectholes and to spray stems; 3. Biological control, pouring into insectholes with 1000-2000 Steinema feltiae per milliliter. After the methods were used. the mortality of H. insularis was 79-92.6% . which lowed cost and could be applied in large areas.

#143

PRELIMINARY STUDY ON CONTROL OF MONOCHAMUS ALTERNATUS HOPE.

Zhang Liangin, Song Shihan, Huang Huanhan and fan JunXiang
Forestry Research Institute of Guangdong province, Guangzhou 510520 China

Japanese pine sawyer (Monochamus alternatus Hope)is an important wood borer of pine tree and vector of pine wood nematode.They can be trapped by attractants.The ecnomical and suitable concentration for attraction is 1:3.The best attractant is No:1,the second ones are the mixed solvent of No:1 and No:2, and No:4.The number of the insect attracted by attractant tree is 17.8-54.9 times higher than control tree,1.2-3.2 times higher than fallen tree, and 5.79--7.15 times higher than withered tree.The rate of withered tree is reduced 2-32% after being used attractants in pine stands. The actual control effect is about 70-95% .To use some 1:1 oxidize rogor solution, at the same time, the larvae will be killed about 62.4%-100%. Scleroderma guani Xiao et Wu is released in pine stand(28142 head per ha.)the control effect of contemporary generation is about 40-50%, the continual control effect is ahout 69.63-85.33% in three or four months.

#144

EFFECT OF TROPICAL RAIN FOREST CLEAR-CUTTING ON DUNG BEETLES (COLEOPTERA: SCARABAEINAE). THE SCARABAEINAE AS PARAMETER FOR THE ANALYSIS OF RAIN FOREST DIVERSITY.

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Since 1964 dung beetles have been sampled in various tropical rain forest in Southern México. With this information we analyzed the long and short term effect of rain forest clear-cutting on the Scarabaeinae guild. Three rain forests were analyzed: Boca de Chajul, Palenque in Chiapas, and Los Tuxtlas in Veracruz. The guild of dung beetles has a similar structure in these forests: there are between 23 to 27 species; non rolling beetles dominate over rolling-beetles; generalist species predominate over necrophagous and coprophagous species; nocturnal are more abundant than diurnal species. Dung beetles in Palenque were also sampled in an edge, and in a recent clear-cut. Twenty seven species were collected within the forest, 11 on the edge, and 5 in the cut zone. In a pasture, that was a rain forest before, near Laguna Verde, Veracruz, the dung beetle guild have 18 species with only 4 species of the original forest; diurnal species predominate over nocturnal species and coprophagous are more abundant than generalist species.

Results suggest that the clear-cutting of the tropical rain forest in the short term affects mostly the species that live within the forest, the species that live in the edge have greater possibility of the adaptation in the clear-cut areas

#145

THE APPLICATION OF NUMERICALTHEORY IN EVALUATING THE EFFECTS OF BURNING ON BEETLES. Wenli-Xu (Forestry Bureau, Department of Agri-forestry of Jiangsu Province, Nanjing 210008, China)

The paper mainly analyses the effects of burning on beetles quantitatively, reveals the short-term and long-term effects of burning, probes into the change rule of beetle's population density. The obtained sample data is as a sample matrix. In time of burning, the different stack height of logging residues(100,60,30,0cm), the slope-site(hilltop, hillside, downhill), and the average temperature and rainfall are as variables, the population density of beetles is as dependent variable. Based on the collected data, applying numerical theory(1) model: $yi=\sum_{j=1}^{m}\sum_{k=1}^{Y_j} xi(j,k)bjk+\varepsilon i$ $(i=1,2...n)$ according to the principle of linear regression, with the help of computer, working out the solution of equation X'Xb=X'Y, the score(bjk) of each variable is got. Main conclusions are as follow:

1. The effects of burning are different among different stack height of logging residues, the score arrange of it is 0cm(2.095) >30cm(0.762)>60cm(0,528)>100cm(0), it means the higher the stack of logging residues and the more the decrease of beetle's population density. 2. The score arrange of slope-site is hillside(1.286)> downhill(0)>hilltop(-1.036). It means the amount of beetles on hillside is most, secondly is downhill, and then is hilltop. The is because the beetles have the character of phototaxis, most of them active on hillside. 3. With the season change of temperature and rainfall, the population density beetles fluctuates. commonly, it increases with the increase of average temperature and rainfall. 4. Through Analysis of Covariance, burning has notable effects on the population density of beetles, it decreased 52.6% after burning.

#146

THE INTEGRATED MANAGEMENT SYSTEM OF PINE CATERPILLAR DENDROLIMUS PUNCTATUS WALKER. Xiao-ming Ma (The Center of Environmental Sciences, Peking Uni., Beijing 100871, China)

Using the system analysis method, pine caterpillar-pine system structure property and moving regular pattern was studied. For key links in the system three models viz. pine caterpillar population dynamic model, needle and wood volume growth model of pine and integrated management optimizing policy making model were developed, which were combined to build a systematical model of integrated management of the pine caterpillar.

The integrated management system software were made. The software which adopted key technology of GIS has the space date input and processing functions and can simulate and predict the variation in the distribution and abundance of the pest population and can aid managers to make control policy.

Hungpu Forestry Experimental station is located at Qianshan County of Anhui Province. The simulation results of the population dynamics coincide with the real occurrence laws of the pine caterpillar. The system optimizing computation results indicate, on total control area, optimum policy was uncontrol for first generation and control above 10 larvae per tree for overwintering generation; on the total costs and losses of needle, optimum policy was uncontrol for first generation and control above 3 larvae per tree for overwintering generation.

#147

THE APPLICATION OF EXPERT SYSTEM FOR FOREST PEST MANAGEMENT IN CHINA. Zhen Zhang (Research Institute of Forestry, Chinese Academy of forestry, Beijing 100091, China)

The newly emerging technique, Expert System (ES) has been appliend in forest pests management since 1980's. In recent years it has also been adopted in China. The ES for the control of the pine caterpiller, Dendrolimus punctatus and the ES for identification of the pine insect pests are two newly developed systems established by the author, the former is a rule-based system and the latter is a neura network system. Both systems have been proved to be successful and practical in some forest farms in Hunan and Guangxi province. Besides, an intelligent prediction system of pine caterpiller, D. punctatus has been developed in Nanjing Forestry University.

Key words: Expert System, Pest Management, Dendrolimus punctatus.

#148

DESCRIPTIONS OF THE GEOMETRIDS (LEPIDOPTERA: GEOMETRIDAE) OF CAMPHOR TREE FROM CHINA. You-gong Li, Shun-li Chen, Liu Li (Fujian Forestry College, Fujian 353001, China)

Seven species of geometrids which damage camphor-tree have been recorded in China. They are: Thalassodes quadraria Guenee, Trigonoptila latimarginaria Leech, Hypomecis punctinalis conferenda (Butler), Terpna amplificata Walker, Thalassodes auets Trout, T. opalina Butler and Boarmia acaciarta Boistural.

This paper gives a report on eleven species of the geometrids of camphor-tree. They are: Thalassodes subquadraria Inoue, Trigonoptila latimarginaria Leech, Hypomecis punctinalis conferenda (Butler), Ascotis selenaria (Schiffermuller et Denis), Dindica polyphaenaria (Guenee), Hyposidra aquilaria Walker, Trigonoptila straminearia (Leech), Corymica arnearia Walker, Ectropis abliqua Prout, Racotis boarmiaria (Guenee) and Xandrames latiferaria Walker. Among them the forth to eleventh species are recorded for the first time from China on damaging the camphor-tree. The morphological characters and the simple bionomics are described except for Thalassodes subquadraria and Trigonoptila latmarginaria.

#149

THE ESTABLISHMENT AND ANALYSIS OF LIFE TABLE OF DENDROLIMUS PUNCTATUS OF 3-4 GENERATIONS PER YEAR. Shi Zhongmei (Guangxi Forest Research Institute 23, Yongwu road. Nanning Guangxi 530001, China)

Life tables of 25 generations of D.punctatus were established after eight years systematically research from 1982 to 1989 in Qing Zhoug city, Guangxi province, which has made the natural enemy community complex clear. Study on life tables showed that the main factors causing the change of the population quantity of D.punctatus were biological ones and, among these biological factors, the predation on Larvae and the parasite of pupae of D.punctatus by natural enemies performed more important roles. It was found that the Losses of the 1st to 3rd instar Larvae caused by predatory natural enemies and other reasons were the key factors causing the change of the population quantity of D.punctatus. AnaLysis with Price Method showed that it is suitbale in the 4th instar to take protecting measures over the D.punctatus. This research has played an important role in the exploitation and application of natural enemy resources as well as in the improvement of the integrated managing effect on D.punctatus.

#150

VERTICAL DISTRIBUTION OF LONGICORN BEETLES IN ALTAI MOUNTAINS AND THE PLAIN IN FRONT OF THEM. Jian-xin Kang (Altai Mountains Forestry Bureau, Altai city, Xin Jiang, China)

Altai Mountains and the plain in front of them cover the area from the east longitude 86° - 90° 10', and the north latitude 45° 45'- 49° 10'. 39 genera and 70 species (including subspecies) were collected in 1982-1990. The longicorn beetles in this area can be devided into three vertical belts (1) belt of mountain taiga (alt. 900-2600m) (2) belt of valley broadleaved mixed forest (alt. 500-900m) (3) belt of Zhungeer Basin desert (alt. 400-500m). About 76% of species in the first belt belong to Euro-Sibirica component and 2% middle Asia component; 73.68% Euro-Sibirica and 15.7% middle Asia in the second; 85.7% middle Asia ones and no Euro-Sibirica ones in the third. Altai Mountains are situated in Ancient Northern Region, so all of the longicorn beetles in the area are Palacarctic without Oriental.

#151

THE TRENDS OF FOREST INSECTS RESEARCH IN CHINA. Xiao-qin Wu (Nanjing Forestry University, Nanjing 210037, China)

Based on Chinese Forestry Abstracts edited by Scientific and Technological Information Center, Ministry of Forestry, the paper analysed systematically the materials on forest insects in the recent seven years (1985-1991). The published literatures on forest insects (including mites and spider) were totally about 4780 in these years, and average in 670 each year. The relative proportion of each research field were about: physiology 2, pathology 4, forecast 4, ecology and geography 9, pest survey 9, biology 10, taxonomy 11, management 51, and that of in pest management about: plant resistance 1, control by hand 1, salvicultural measures 1, physical control 1, quarantine 3, biological control 26, integrate management 32, chemical control 35, respectively. The main dynamic status, trend etc. in every discipline were discussed.

#152

A STUDY ON THE FAUNA AND ECOLOGIC DISTRIBUTION OF SWALLOWTAIL IN HAINAN ISLAND. Maobing Gu, Peizhen Chen (The Research Institute of Tropical Forestry, CAF, Guangzhou 510520, China)

41 species of swallowtail have been collected in Hainan Island. Many of them are typical species of Orient region. According to counting per unit area, Hainan Island is one of the richest swallowtail district. The topmost appearance period of swallowtail species are found in April - May every year. Most of the swallowtail species are distributed in tropical semi-deciduous monsoon forest, tropical evergreen monsoon forest and tropical mountain rain forest. In tropical mountain rain forest, the community structure are quite complex, species of living beings are abundant, 37 species of swallowtail have been collected, accounting for 90% of the total whole Island. 12 species of them are peculiar species in tropical district and tropical mountain rain forest. Some rare species of swallowtail, for example, Teinopalpus aureus, Papilio doddsi, Chilasa paradaxa, Atrophaneura dasarada etc, are all distributed in tropical mountain rain forest. So long as tropical mountain rain forest is well protected, those rare butterflies are protected also.

#153

STUDY OF PINUS SYLVESTRIS L. XILOPHAGOUS CERAMBYCIDS USING ARTIFICIAL DIETS. Notario, Antonio and J.R. Baragaño. (E.T.S. de Ingenieros de Montes, Madrid, Spain).

A systematic, ethological and economic study about xylophagous cerambicids, present in stumps of Pinus sylvestris L. at Monte de Valsaín (a well known forest in the province of Segovia, north of Madrid), was accomplished during 1989 and 1990.

The breeding chamber and artificial diet described in de Viedma et al (1985) were used, and 10 species of cerambicids were detected as a result: Rhagium inquisitor, R. bifasciatum, Corymbia rubra, Anastrangalia sanguinolenta, Brachyleptura strangulata, Ergates faber, Hylotrupes bajulus, Arhopalus tristis, Spondylis buprestoides y Acanthocinus aedilis.

#154

STUDIES ON QUANTITY OF OVERWINTERING ENERGY SUBSTANCES AND THE SUPERCOOLING POINT OF DEDROLIMUS SUPERANS (BUTLER). Kuanyu Liu, Changxuan Gong, Defu Chi (Northeast Forestry University, Harbin 150040, China)

From Nov. 1988 to Apl. 1989, the quantity of fat and sugar, as well as the fluctuation of nutrition of D. superans was tested monthly. The inner water and the supercooling point were tested Monthly. The inner water and the supercooling point were tested each month also. The results showed that the lower the temperature is, the higher the quantity of hydration water and the lower the quantity of unhydration water are. At the same time, the supercooling point gets lower and lower, all of which would benefit the overwiter of this pest.

#155

THE OUTBREAK CAUSE AND CONTROL OF LARCH CAPTERPILLAR DENDROLIMUS SUPERANS (BUTLER) IN DA XINGAN MOUNTAINS. Kuanyu Liu, Lirun Wang, Zhiying Wang, (Northeast Forestry University, Harbin 150040, China) Huanzhang Cheng, Xhanbin Xu, Zenghe Pang (Da Xiangan Mountains forestry Administration, Heilongjiang Province)

A serious outbreak of larch capterpillar was reported in Da Xingan Mountains in 1990. More than 1 million ha of larch stands were defoliated, and some stands were completely defoliated. Consequently, the pest outbreak resulted in a major economic loss. The main reason for this outbreak is the decrease of mature and overmature stands and the increase of young larch stands during last two decades' exploitation in this region. Also, the ecological conditions changed greatly in those stands as a result of this exploitation. Another reason is the significant changes of climatic factors, which created a favorable environment for the outbreak of this pests. So, the favorable outbreak conditions caused by the significant changes of ecological environment in this region could be attributed to this outbreak. The control methods for this pest were also discussed in this paper.

#156

RESEARCH ON THE INTEGRATED PEST MANAGEMENT FOR CONE AND SEED INSECTS IN CHINESE PINE SEED ORCHARD. Kuan-sheng Li, Xin-gang Li, Wen-jie Suen, Hong-zhe Wang (Shaanxi Institute of Forestry Science, Yangling, Shaanxi 712100, China)

Among 13 species of cone and seed insect pests for Chinese pine, 3 species - *Gravitarmata margarotana* Heinemann, *Dioryctria pryeri* Ragonot and *Dioryctria rubella* (hampson) are the most harmful pests. According to the characteristics of Chinese pine seed orchard, the species bio-properties of cone and seed insects, and the control experience and studies during the past years, the paper proposes strengthening the seed orchard management to improve its ecological condition, making the smallest possible use of general pesticides in large area, and using widely the silvicultural, mechanical and non-killing of natural enemy methods to control pests to achieve the beneficial circulation of the integrated pest management of cone and seed insects in seed orchard. Finally, the strategy, principles, programme and measures of integrated pest management of cone and seed insects in seed orchard, and the steps and methods for estimating the integrated pest management of cone and seed insects are also proposed.

#157

INVESTIGATION OF OVERWINTER POSITIONS OF *DIORYCTRIA PRYERI* RAGONOT. Kuan-sheng Li, Wen-jie Suen, Xin-gang Li (Shaanxi Institute of Forestry Science, Yangling, Shaanxi 712100, China)

Dioryctria pryeri Ragonot is an important insect pest of cones and seeds for conifers in China. The reports on the insect generation development and living behaviors are basically the same, and reports on the overwinter positions are much different. In respect to this problem, authors make a comprehensively investigation since 1987 and find that the overwinter position of larvae is concentrated mainly in the second-year male inflorescences, and insect density is positively related to the amount of male infloreseences. The corresponding control measures are proposed: (1) controlling the ratios of male trees to females in seed orchards and seed production stands; (2) plucking, downing and blowing down the rest male inflorescences of trees in the autumn and winter; (3) spraying chemicals on the pine trees with more male inflorescences.

#158

STUDIES ON PROPAGATING CPV BY USING HIGH DENSITY OF DENDROLIMUS PUNCTATUS (WALKER) IN FOREST. Chang-fa Deng, Ning Zhang, Si-ming Chui, Ding-jie Yie, Zai-fu Xu (Institute of Forestry Science, Maoming, Guangdong 525000, China)

In the southwest of Guangdong province, the measure of using high natural density of D. punctatus to reproduce CPV was simple and effective, which benefited both controlling pest and reproducing virus. The best generation and good instars were the fourth generation and V, VI instars respectively; the first generation can also be used to reproductive virus. The spraying concentration was $1\text{-}5\times10^{6}$ CPV/ml. The key technigues were evenly spraying and collecting infectious larvae on time. After 510 hectares were controlled, 6.7 tons infectious larvae were collected which were in turn used in 30 thousand hactares, the good applied efficiency was achieved.

#159

STUDIES ON THE PROCEDURE OF EXTRACTING CPV OF DENDROLIMUS PUNCTATUS (WALKER). Chang-fa Deng, Ding-jie Yie, Ning Zhang, Xi-ming Chui (Institute of Forestry Science, Maoming, Guangdong 525000, China)

There are simple equipment demands and high efficency by using procedures: chipping, stirring, rinsing, filtering and centrifugalizing to reconstruct CPV. The rate of CPB extracted was over 80%. Compared with common methods, thses made impurity in the extracted crude decreased by 43-76%, the number of CPB per unit increase 0.68-3.3 times and the cost decline strongly. The relationships between the rate of CPB washed out and the number of stirring, the amount of water added over stirring were positive, the amount of water added were at least 5 times of original volume. Among certain range, the depositing time of liquid has a positive relation with the rate of extracting. By using these procedures 6.7 tons of infectious larvae were produced 2.25 tons crude matter containing 10-12 billion CPB per gram were gained. 3 thousand hectares were controlled.

#160

STUDIES ON BIOLOGY OF ACANTHOLYDA POSTICALIS MATSU. Wei Lou, Yuwei Dai (Institute of Shelter Forest, Heilongjiang 161041, China), Aiju Hou (Northeastern Forestry University, China)

A. posticalis is a leaf-eaten pest in forest. There is a generation in Heilongjiang province. The eldest larvae are overwintering in the earth, adults emerge at June next year, newly-born larvae turn up at the middle and late of June. The development threshold and thermal constant of eggs are 13.48±0.78℃ and 106.72±11.37 day degree. Its larvae eat leave of camphor tree. The economic threshold is that 40% of leave is lost, economic threshold are there are 4 larvae in a 50cm standard twig. The number of overwintering larvae and the two following equations are used to forecast pest occuring number: $P=Po\{exf\ (m-f)\times(1-m)\}$, $I=e\ e_{o}$. Distribution of larvae was convergent. Iwao measures were used to determine the number of sampling. Several keys affecting population dynamics were studied by life table. Integrated managements were discussed and used in controlling the pest, the significant social and economic efficiency was achieved.

THE EFFECT OF CHEMICAL CONTROL ON THE INSECT COMMUNITY IN MASSON'S PINE STANDS. Li-zong Ren(Institute of Forestry, Chinese Academy of Forestry, Beijing 100091,China)

From April of 1989 to April of 1990, the effects of chemical control on the insect community(including spiders) were studied combining with the work of controlling the pest Dendrolimus punctatus conducted in Qianshan County, Anhui Province. The results indicated that the species in the community is more abundant during the period of the pest outbreaking but the eveness and diversity index of the community were lower than those of the community of the control plots. After the pest was effectively controlled by insecticides, it was difficult for the pest to return to a high population density; the species in the community was less abundant at this time, and the diversity index was higher, because the eveness had increased greatly. Each measurement index for community showed a similar change tendency with that of the control plots. Chemical control not only decreased the pest's population density but also killed a lot of natural enemies of the community. But the effects of insecticides on different groups of natural enemies (beneficial insects and spiders) were different. Beneficial insects were greatly affected by insecticides, and the species and individuals in this group decreased rapidly after chemical control; spiders were little affected and showed great resistance to the insecticides. The populations of the beneficial insects were more dependent on the population density of the pest than that of spiders both in species and individuals.

SILVICULTURAL MANAGEMENT OF PINE CATERPILLAR, DENDROLIMUS SPECTABILIS, A DEFOLIATOR OF PINE TREE-INDUCED RESISTANCE OF PINE TO THE PEST (2) . Zhangyi Zhou, Zhizhong Zhang, Jinghui Li (Beijing forestry University, Beijing 100083, China)

The photosynthesis rate, tree vigour and its resistance to Dendrolimus are found to be increased 30% defoliation or reasonable pruning. However, over defoliation of pruning would make photosysnthesis and tree vigour declined, with the proper rate of defoliation, the decrease of total foliage is more than that of total amounts of photosynthetic products. It means the relative improvement of nutrition status in the remained needles. As a result, the decreased contents of starch and soluble carbohydrate, and the increased contents of fat and protein are beneficial to the growth of dendrolimus and could weaken tree resistance. Removing the current needles causes stronger nutrition effect than removing the old ones, and defoliation plus pruning stronger than pruning only.

Most current needles of P. tabulaeformis are on the forth branch whorl. They are extremely important to the maintaining amounts of photosynthetic products. So 4-5 year tree is not suit to pruning. Attrition should be paied to the protection of growth of the forth branch whorl. Pruning should carried out after 6 year and it is wist to remain fifth whorl.

STUDIES ON THE SPATIAL DISTRIBUTION MODEL. BIOLOGY AND CONTROL OF BOX-TREE PYRALID. Xue-ying Chen (Beijign Forestry University, Beijing 100083, China) Zhong Zhan, Yun-xia Zhan (Gardens Mechanic School. Xi An)

The box-tree pyralid, Diaphania perspectalis, is one of the main pests of the box tree. Buxus sinica, which injured the tree seriously. The spatial distribution model of the larvae is cluster distribution. It has three generations a year, the larva has six instars. Overwintering takes place as second instar larva in white cocoon by leaf-tier. The larvae feed on the leaf separately after third instar. The fifth and sixth instars are able to feed on entire leaf. The mean leaf-eating capacity of each larva is 82.3 tablets. Plucking the cocoon or spraying fenitrothin, 50% dichlorvos, 50% phoxim, 80% trichlorphon emulsions of a dilution of 1:800 obtained a dead rate over 93.5%.

PRELIMINARY STUDIES ON EIGHT GALL-MAKING CYNIPIDS AND THEIR NATURAL ENEMIES IN CHINA . Luo Youqing, Huang Jingfang(Beijing Forestry University, Beijing 100083 , China)

Field survey has collected a total of about 30 gall-making Cynipids from 12 provinces in China since 1980. Eight of them, namely Neuroterus spp. (3 species) , Bihoriza sp., Dryocosmus kuriphilus, Andricus sp., Andricus nudus,Cynips sp., were studied indetail, including the morphological characteristics of the galls. Gall wasp and galls were dissected described and photographed, Classification, parasization, population ratio and parasitism of parasitic wasp were studied. 40 parasite species were reared from the gall of 8 cynipids, 33 species belong to Torymidae, Eurytomidae, Eupelmidae, Ormyridae, Eulophidae (broadly speaking) , Pteromalidae, Elasmidae etc. (Hymenoptera). Most of them are primary parasites . some are hyperparasites, of both primary parasites and hyperparasites. Food-web among gall making cynipids-parasites-inquilines-plants was drawn.

A STUDY ON THE OPTIMIZING DECISION MAKING OF PINE CATERPILLAR, DENDROLIMOS PUNCTATUS WALKER, MANAGEMENT. Xiao-ming Ma (The Center of Environmental Sciences, Peking Uni., Beijing 100871, China)

Based on detailed analysis of differences between the pine ecosystem and the cropland ecosystem with adequate consideration of stability of the pine ecosystem and the dispersal property of the pine caterpillar, the optimizing decision making model was established by method of dynamic programming technology.

Objictive Max E

restraint: $0 \leqslant J(t_1, t_2) \leqslant T$

$0 \leqslant K(t_1, t_2)$

J is a integral

J is a code name of control means including insecticide used and other control ways. K is a dynamic control threshold. E is the pure benefit of control means in 7 years.

E = control costs + losses of needle and wood volume.

The Model Solving steps:

1) for every J, seek $K^* = R(J)$ to make $E(J,K^*)=\text{Max}\{E(J,K)\}$,

2) select J^*, to make $E(J^*, R(J^*))=\text{Max}\{E(J, R(J))\}$.

The solution of dynamic programming $^{J}(J^*, K^*)$ is also called the optimizing decision.

THE INTEGRATED CONTROL OF HOLCOCERUS INSULARIS STAGR. (LEPIDOPTERA: COSSIDAE). Xue-wen Liu (Beijing Forest Bureau, Beijing 100029, China)

The goat moth Holcocerus insularis Stagr. is a serious insect pest of may trees (Crataefus pinnatifeda Bge) in Beijing suburb. It can greatly decrease the fruitage and growth of the may trees. Seriously infected trees may be killed by the cossid.

Experiments showed that the following control measures were effective: Agrotechnical control measures: In winter pruning off dead limbs or cutting the infected thick branches; applying a white wash coat on the trunk in June; filling the burrows of the trees with yellow clay; manuring and watering from April to May. Chemical control: From April to May and from September to October injecting organophorus insecticides into the burrows of may trunks; from June to July spraying the same pesticides into the infected trunks. Biological control: Injecting suspension of Steinernema feltiae (1000 to 2000 larvae/ml) into the burrows of the tree trunks from April to May and from September to October. The mortality of the cossids can reach 79-92.6%.

A PRELIMINARY REPORT ON THE DAMAGE OF HALYOMORPHA PICUS (HEMIPTERA, PENTATOMIDAE) IN PEACH ORCHARDS. Ying-nan Wang, Jing-yu Hu, Xiu-min Lin (Institute of Plant Protetion, Beijing Academy of Agricultural and Forestry Sciences, P. O. Box 2449-19, Beijing 100081, China), Lian-di Tang, Hui-fen Zhang (China Ministry of Machinery and Electronics)

In recent years, Halyomorpha picus has been found to cause increasingly serious damage to peaches in North China. It is considered difficult to control due to their long occurrence period and moving habit. This paper reports the result of studies in Beijing, 1991, which showed that the act of H. picus moving into peach orchards from overwintering places (eg. houses, wild field), began at the stage of flower drop and lasted 4-5 weeks. The bugs can damage fruits during the whole growth phase (about 80 days). The serious injury occurred from late June to mid-July, with in these 20 days damaged fruits occupied 53.2% of all that of 80 days. The rate of damaged fruits in directions near the outside sources of the pest (overwintering places) was higher than that in other directions, and that in border rows was higher than that in the centre. Isocarbophos and deltamethrin both proved to be effective on the bugs but isocarbophos killed more rapidly than deltamethrin in laboratory experiments.

STUDIES ON THE BIOLOGICAL CHARACTERISTICS OF CHINESE PRIKLY ASH (CPA) IANTHOXYLUM BUNQEANUM AND ITS PEST CONTROL. Ming-yi Guo, Sen Guo (Forest bureau of Xinzhuo prefecture, Shanxi, 034000, China), Li-zhong Wang (station for forest disease & pest control and quarantine of Shanxi, Taiyuan 030000, China).

This paper described the biological characteristics both of the CPA and of its main pest Calloides agnificus (pic), Podagricomela shirahatai Chujo and Aphis gossypii Glover. The phenology of CPA were studied and its knowlege was used for detect the proper date for control of CPA. And the practical control was made successfully. The methods of control include the measures of plant forest, help to migrate and protect the natural enemies of CPA, and chemical control with 40% of an emulsion (39% of Dimethoate + 1% of Fenvalerate, and sprayed by a dosage of ×1500) . All of them, obtained a significant effects of control, which resulted in a mortality of pest over 95%. Therefore, There was a great harvest of CPA in control area.

THE RESEARCH OF THE ECOLOGICAL CLASSIFICATION OF THE OCCURRING PLACES OF PARATETRANYCHUS SP. Dian-yi Wu, Liu Xiaolin, Chen Weidong (The Forestry Bureau of Qianxi county, Hebei 064300, China)

The differences of some environmental factors of the chestnut Castanea mahissima tree stands can making the occurring quantity and damage level of Paratetranychus sp. obviously different. The Paratetranychus sp. occurring places can be classified into different ecological type. We can make ecological or chemical control decision on the base of ecological type classification so that we can make full use of control effectiveness of environmental factors to the pest. After survey and analysis, the hill slope direction and soil condition are chosen as the main factors, temperature and moisture are chosen as the assistant factors for classifying the ecological type of Paratetranychus sp. occuring places. In the light of the above principle, the Paratetranychus sp. occurring places in Yanshan mountain are classified into three types: serious damage places(south slope, thin soil layer places), ordinary damage places(west slope, medium soil thickness places),scattering places(north and east slope, thick soil layer places). Different control measures are given to different ecological type places. Control stress are put on serious damage places, inspect ordinary damage places. And scattering places are safe. This control principle is easy to be applied and has been in use in Qianxi county for three years and has obtained very good result.

STUDIES ON OCCURRED PATTERN AND MASS-REARING OF SCLERODERMA SP.. Yu-tian Wang (Forestry Bureau Shanxi 030002, China), Zhiyong Zhang (Shanxi Agricultural University, Shanxi 030801, China)

Scleroderma sp. is an extraparasitoid of some borers which parasites the larvae and pupae of them. Under the conditions of 25℃ and 70%RH, its development time is 4.55 dasy in egg period; 7.06 in larva; 16.8 in pupa; 28.4 from egg-laid to adult emerging; 32.8 in female; 8 in male. There are 10-11 generations within a year. The sexual ratio of F: M is 17. 04: 1. The female can reproduce without being mated, but the percentage of females in next generation is only 5.6%. When adults are released on the base of twigs, they creep upwards to look for hosts, they drop off at a certain height then climb again. Female eats silk of cocoon— as supplemental food. The larvae of Saperda populnea were used for the mass-rearing of the wasp. S. populnea is easily collected and stored. In the high sea-level and cold areas the pest has one generation within two years, so it can be collected by pruning forest in the winter for mass-rearing wasps, then the wasps are released in tree growing season to control S. populnea, Chreonom fortunei and so on, the ratio of pest: wasps was 1:3, the parasitism achieved 55.17-90.47%.

THE OCCURRENCE PATTERN OF GRAPHOLITHA MOLESTA BUSCK AND ITS CONTROL IN BAMEN DISTRICT OF INNER MONGOLIA. Hua Zhen (Department of Horticulture, Inner Mongolia College of Agriculture & Animal Husbandry, Huhhot 010018, China), Shuangping Lu (Fruit Tree Research Station of Agricultrue Bureau of Linhe City, Linhe 015000, China)

Peach moth (Grapholitha molesta Busck) occurs three or four generations annually in Bamen District of Inner Mongolia. There are four peaks of the adults from April to september. The first and second generations mainly infest newly developing branches of plum trees and young fruits of pear trees. The third and fourth generations infest pear fruits. In the experiment, the following measures were adopted in order to control its infestation: scrapping the bark in the early spring, cutting out infested branches of plum trees, forecasting the pest's emergence period with sex pheromones traps and spraying insecticides in time. The bored fruit rate declined from 50% to 4-7% and better economic benifits and control effects were achieved.

STUDIES ON THE BIOLOGICAL HABITS AND CONTROL OF SCOLYTUS PARVICLAVIGER YIN ET HUANG. Ju-pu Chang (Puyang Institute of Forestry Science, Puyang, Henan 457000, China)

S. parviclaviger is a boring species, which has been found making holes in Ulmus pumila in the northern Henan recent years. It harmed not only weak and dying trees, but also healthy trees. Larvae and adults in complemental feeding stage ate in pholems of the trunk and limbs of elm aggregatively. Therefore, it often resulted in the cutting of the liquid flow paths and the wither of the tree. S. parviclaviger occurred one generation each year. It overwintered with larval stage and began to move and feed in early April next year. Adults had weak photokinesis and thanatosis. Degree of damage caused by its boring was co-related with the environmental conditions, weak trees were heavily damaged. Reasonable methods of control were also proposed.

A STUDY ON A FEW ECOLOGICAL ISSUES OF PINE-CONE WEEVIL (PISSODES VALIDIROSTRIS GYLL. Shukui Yue, Zhiying Wang, Gocai Zhang (Northeast Forestry University, Harbin 150040, China)

This paper reported the status of the population dynamics of pine-cone weevil (Pissodes validirostris). The density of population of the pest is relatively stabl. The relationship between yield of cone and the density of pine-cone weevil was found. The status of overwintering mortality of pine-cone weevil was analyzed and the emergence in spring was studied. Those studies provided a foundation for the forecast and control of pine cone weevil (P. validirostris.)

BIOLOGICAL CONTROL OF ACANTHOLYDA POSTICALIS MATSUMURA. Aiju Hou, Wei Lou, Jingquan Tian, Dunliang Yan (Northeast Forestry University, Harbin 150040, China)

Acantholyda posticalis is an important defoliator for Pinus sylvestris, P. tablaeformis and P. koraiensis. It was first found that natural enemy, Formica fukaii Wheeler played some role in regulating A. posticalis population. Its morphology, biology, artificial removing and control effectiveness have been studied. The results show that the ants are strong and effective predators which could reduce 57.7% of larvae of pine sawfly and 50% of adults. Ants of one nest can prey 1, 340 larvae per day. This ant is a dominant species. Meanwhile, a kind of entompathogenic nematode (temporarily called No. 4 of NE. FOR. UNIV) was isolated from naturally died pine sawfly prepupa. They could be cultured in both artificial medium and in vivo. The artificial medium is a mixtrue of chicicea, cream, water and sponge with the ratio of 9.8:1.4: 2.8:1.0, and evenly blended. The mortality of pine sawfly larvae caused by using the nematode was 89.3 percent indoor and 46.1 percent, 59. 3 percent outdoor.

A STUDY ON THE DETERRENT FUNCTION OF TANNIN IN POPLAR TO CRYPTORRHYNCHUS LAPATHI L. Jingquan Liu, Jiwen Cai (Northeast Forestry University, Harbin 150040, China), Yuntai Qi, Guoming Cen, Wenjun Fu (Shanghai Institute of Entomology, Academia Sinica)

The extraction analysis and biological measurement of tannin content in tree barks from 12 species of poplar have showed that tannin is a distinct restrain to osier weevil and whether a tree is damaged by pests is directly related to its bark tannin content. If the tannin content in the bark over 2.06 mg/g (dry bark weight), the damage is very slight, and we consider it as pest resistant tree such as P. davidiana, P. koreana, P. pesudosimonii, P. pachydermis, P. cathayana, P. xiaohei Hwang CV-14. If the tannin content less than 1.88 mg/g, the damage is moderate or heavy, and we consider it as pest infected tree such as P. russkii, P. canadasis, P. berolinensis, P. euramericana and P. stalin tz.

PRELIMINARY STUDYON THE PHYSIOLOGICAL CHARACTERS OF COLEOPHORA DAHURICA FLKV. LARVAE DURING OVERWINTERING PERIOD. Huaguo Dai (Northeast Forestry University, Harbin 150040, China)

Changes of the physiological characters of overwintering larva of Coleophora dahurica FLKv. were studied. The preliminary results were summarized as follows (1) Glycogen and fat were the main overwinting energy substances; (2) The metabolic rate of overwintering larvae was very low, and respiratory, quotients varied respectively between 0.96 to 0. 74; (3) The internal water content of larvae were only 50 to 60% in the whole overwintering stage; (4) The supercooling point of larvae were all about 10℃ lower than the lowest temperature at same stage. The results showed that C. dahurica larvae could overwintered favorably well by storing enough overwintering energy substances, decreasing internal water content and metablic rates, and increasing the ability of cold resistance. But if the period of lower temperature of autumn came earlier, and energy substances stored for overwintering larvae were not sufficient, and lower temperatures happened suddenly in the later overwintering period, large number of death of overwintering larvae might occur. The climate conditions of these two periods were the important factors for forecasting occurrence numbers.

INTEGRATED MANAGEMENT OF THREE PESTS ON POPLAR IN LANXI COUNTY. Ming-xu Liu, Wen-chang Gu, Gong-tang Shao, Wei Liu (Station of Forest Pest Control and Quanrantine, Lanxi County, heilongjiang 150001, Chian)

Different kinds of controlling areas were reasonably divided based on the dialectical relationships among the three pests of poplar, Paranthrene tabaniformis Rott., Quadraspidiotus gigas Thiem et Gerneck, Cryptorrhynchus lapathi L. with the forest, the cultural practices, the beneficial enemies and the natural conditions. A flow chart of scientific management system model was made, IPM techniques and decision-making system were also studied. From 1987 to 1989, after these measures were applied in the controtling of the three pests in different areas, the average percentage of trees infesting the pests decreased from 37% to below 1%, controlled areas were 75,920 hectares, and the effective economic, ecological and social benefits were also been obtained.

FOREST INSECTS WERE INVESTIGATED IN XINJIN COUNTY. Jian-you Pan, Xiang-xiao Liu, Jia-zhou Ji (Forestry diseases and insects protection station of xinjin County, Dalian 116200, China.)

Forest insects had been investigated in Xinjin County from 1979 to 1989. They belonged to 16 orders, 88 families, 1277 species, of which 586 species had been identified. Among them 38 families, 814 species belong to Lepidoptera of which 432 species were identified, 13 families 198 species belong to Coleoptera, of which 101 species had been known. Collection time, distribution, host and collector had been recorded.

RESEARCH FOR THE FORM OF THE FOREST INSECT REGIONSERIES AND ANIMAL GEOGRAPHICAL DIVISIONS. Jin-feng Lin (Control and Quarantine Station of Forest Diseases and Insect Pests, Dalian 116001, China)

By investigation the species of forest insects of Dalian District, this report had determined 17 orders, 184 families and 704 species. The conclusion is that: according to the insect geographical divisions of the world, 56.25% forest insects in Dalian district belong to the kinds of the palaeonorth region, 30.39% are closest relation to the East Pacificocean Region but more estranged from the Newly Tropical region; according to animal geographical divisions of China, they belong to the northeast region, and are closest relation to the north China region, closer relation to the middle China and Mongolia-Xinjiang region, but estranged from the Qingzang region. This report divides forest insects of Dalian district into two subregions-northern mountainous distribution and southern hill coastal terrace island distribution.

INVESTIGATION OF INSECT FAUNA OF LIAONING PROVINCE. Zhiyu Wang (NO 6, 4 Duan Changjiang Street, Shenyang 110031, China)

This research was carried out on the basis of ecology theory and taken the method of line investigation with samle plot investigation and field collection. The investigation area is more than 90% of total forest area of Liaoning Province. In three years, 266, 722 specimens were collected and 2,596 species have been identified. The results shows that the insect fauna of Liaoning province are close to that of Huabei. According to insect species distribution, occurrence and phytocoenoses, forestry successtion, location, geographical conditions, meteorograph factors etc., the authors have divided Liaoning Province into 4 regions and given guide principles to control pest for every region.

THE PROTECTED PRODUCTION OF BIVOLTINE TUSSAH. Zhongshu Wu (Dept. of Agriculture & Animal Husbandry, Liaoning Province, Shenyang 110001, China)

The method which use a plastic membrance cover the young bivoltine tussah can protect the young tussah grows safely, resists to natural damage. It can increase the porduction of tussah. Cardboard box production in door: the tussah room and, tools should be disinfected by 3% Formalin before the production of young tussah. The fussah bed is 2 meters long and 1 meter wide. The plastic is 30 m larger than the tussah's bed. The cardboard box for tussah growth is 47 cm long, 36 cm wide, 19 cm high, feeding young tussah is 3 times a day. The temperature is 21-27℃, the air humidity is 65-75% . The open-close plastic membrance and gauze net production: Digging a pit (6 m long, 1 m wide, 33 cm deep), covering 2 plastic membranes (7.5m long & 1.3 m wide), making a skylight on the plastic membrance, setting a plastic gauze net (50 cm long, 30 cm wide) on the skylight and covering the skylight with a open-close plastic membrance, feeding twice a day. The temperature is 20-26℃. The air humidity is 70-90%

REPORT ON APPLICATION OF BEAUVERIA BASSIANA AGAINST PINE GATERPILLARS IN ARID FOREST REGION. Hongyang Pan, Zheng Hua (The General Station of Forest Pest Control, Shenyang 110031, China)

Two drought-enduring strains of Beauveria bassiana isolated from Liaoning and two common strains from Anhui and Guangdong were produced in solid media and formulated. Tests against Dendrolimus tabulaeformis and D. superans in west Liaoning showed that in the case of monthly mean relative humidity is 62.7% . the mortalities by two drought enduring strains from local which were 65.7% and 63.3% were higher than those by two common strains form the South which were 43.9% and 42.7% respectively. The two mortalities were significant difference. Moreover, the mortality by the fungus and drugs mixed application was no synergism. Significant difference of the mortality of Leis axyridis was showed after spraying dusts of the fungus which was 11.1% . BHC which was 64.6% . the mixed application of them which was 13.3% . and control which was 5.6% . in pine stands in the arid area.

STUDIES ON SOPHROPS LATA FREY. Zhiyuan Wu, Jie Jiang, Yuyin Lin (Fujian College of Forestry, Nanping, Fujian 353001, China)

The Sophrops lata Frey is an important insect pest infesting the Actinida trees in the north of Fujian Province. The beetle can complete one generation per year in Jianning, Fujian Province. Hiberuation of the adults usually begins in mid-October in the soil. The beetle adults feed in early April of the next year, with early April to late May being the peak period, during which they can keep eating the leaves and flowers of Actinidia tree the whole night. They get into and out of the soil at regular times. The females lay eggs singly in the soil in early May, which incubate in late May. There are three larval instars. Its larvae move about in the depth of 1 to 20cm under soil, with in the depth of 8-10 cm being the most cases. The larvae feed on the humus and on the root or cuts off the roots. The old larvae change themselves into pupae in the early September, and in the mid-October emergence take place. But they may remain in the soil for the rest time of the year.

The following measures have been found to be effective for controlling the beetle: 1. To inject insecticide, such as diluted 50% phoxion (1:1000-2000, v/v) into the soil to kill the larvae. 2, Spraying insecticdes 80% dichlorvos emulsion (1:1500, v/v), 40% dimethoate (1:800-1000, v/v) and diluted 2.5% Desis (1:5000, v/v) etc. to kill the adult in the field has been found to be very effective. 3, lamp or ultraviolet lamp to kill the adults.

STUDIES ON THE CARRIER SEMISOLID OPEN CULTURE OF BEAUVERIA BASSIANA AND THE PRODUCTION TECHNOLOGY OF ITS PURE SPORE DUST. Yunwei Li, Desen Jin, keer Yi, Hongda Fan, Liling Liu (Fujian Research Institute of Forestry Science, Fujian 350012, China) Xianjing Chen (Linxia State forest Farm of Longhai County, Fujiah, China)

(1) The column plate-type fermentation pot aeration agitation was adopted in this procedure showing the advantageous of avoiding the fungi contamination and increasing the dissolved oxygen content and the fermentation efficiency. (2) Since the cork granule was used as carrying agent in this procedure, the sporogenous rate was improved significantly with high yeild of 44.5 billions of spores from one gram medium, and it's much better compared to wheat bran. (3) The stirring and scattering turn plate-type whirlwind separating machine was adopted to collect the fungi without grinding the spores and carrier. Furthermore, the spores were fully raised and the separating efficiency of one kilogram of culture materials in a minute was obtained.

The spore content of per gram the product of pure spore dust reached 226.11-242.22 billions of conidia and 221.9 grams of the dust could be produced in one square meter of the medium. The percentage of living spore of the product was 86.2-87%, and it decreased by 8. 6% when the spores were stored for 11 months at 4℃, but it did not effect the field application significantly. The toxicity test showed that the mortality of pine caterpillar larvae reached 100% in nine days but the production cost decreased by 26.6%.

A STUDY ON THE OCCURENCE AND CONTROL OF THE CICALA (ERYTHROMEURA SP.) OF MELIA AZEDARACH. Rongbang Gu (Forest Pests and Diseases Control Station of Linhai, Zhejiang, China)

The cicala (Erythroneura Sp.) is one of worst pests to Melia azedarach. It has one generation per year in Linhai, Zhejiang. Overwintering eggs in the bark begin to hatch from mid April. Nymphs do damage to leaves of the tree from mid aprit to late May and Adults fly from late May to late July. The oviposition and emerge are from mid June to late July, and adults oviposit eggs within the bark. Experimental results showed that spraying with 40 percent of Dimethoate by 1000 times within nymph stage was effective. This paper also discussed the relationship between this insect and Mycoplasm-like-Organism.

STUDIES ON INJECTION OF SYSTEMIC INSECTICIDES FOR CONTROL OF GIANT BAGWORM. Guihua Jiang (Jiaxing Agricultural and Forestry Bureau, Zhejiang, China)

The jiant bagworm, Cryptothelea variegata Snellen, causes severe damage to Taxodium ascendens Bronon and T. distichum Rich, two important shade and shelter tree species in Jiaxing. Field surveys in Tongxiang county showed that 884.000 trees, making up 525 kilometers of shelter belt, were attacked by the insect in 1985. Heavy defoliation was observed on ten-year old trees in seven shelter belts in Puyuan and Wuzhen area in 1987. In this case, no trees were found free from attack. The mean number of the insect per tree amounted to 152, with the highest record up to 1058. Foliage spraying of insecticides had been evaluated and was effective, but produced pollution to crop land and mulberry orchards.

This paper presents that injection of systemic insecticides into holes drilled in tree trunks, within one meter high from ground, shows promising results, with low labour consuming and costs and less pollution. 56% Methamidophos, 40% SN-851 and 40% Omethoate cause more than 90% of the insect to death. The two formers give a better control than the latter. Aiming to minimze the amount of insecticides applied, the regression equations, between expected control effectiveness (Y) and dbh of trees to be treated (X1) and dosage to be injected (X2), are established for Methamidophos: $Y=97.67-2.05X1+5.17X2$, and for SN-851: $Y=104.4-3.83X1+12.67X2$.

TRIALS OF CONTROL OF BAMBOO WEEVIL, OTIDOGNATHUS DOISIS FAIR.. Guorong Yang, Jianyin Chen (Anji Forestry Bureau of Zhejiang Province, Anji 313300, China) Ping Jiang, Zong liang Wu (Forest Insect & Disease Control Station of Zhejiang Forestry Department, Hangzhou 310004, China)

Over 90% of mortality was given by spraying twice (5-7 days interval) with 25% emulsion of Decis at 75-150 ml/ha and spraying with 40% SN-851 at 1500ml/ha or 25% mixed Pyrephrin and Dimethoate caused 100% of mortality in 24 hours at adult stage of O. doisidis in Phyllostachys nidularia cv. smoothsheath stand. Bamboo cavity injection with 50% Tamaron at 0.5ml/plant gave average 97.2% of mortality at larval stage of O. doisidis in Phyllostachys pubescens stand when the shoots was 1.5-2.0 metres high. The economic benefit was significant with large scale application of the treatments.

STUDIES ON RELATIONSHIP BETWEEN OCCURRENCE OF DENDROLIMUS PUNCTATUS WALKER AND DAMAGE OF MONOCHAMUS ALTERNATUS HOPE. Jian-yin Chen (Foresfry Bureau of Anji County, Zhejiang 313300, China)

It is revealed that the occurrence of the pine caterpillar, D. punctatus and the damage of the pine sawyer, M. alternatus had closely relationship. An average of 3.2% of trees were damaged by M. alternatus when D. punctatus was at low density. In the pine stands which have been outbreaks of D. punctatus, averagely 25.9% of infestations was found. There were an average of 46.4% and an maxium of 80.8% of trees were harmed in the stands which the trees with little foliage, 4.3% in the stands which the trees with 1/3-1/2 of foliage and 0.3% in the stands which the trees growing well. The authors considered that the weaken of pine trees caused by D. punctatus was the main factor resulting in the incidence of M. alternatus. In order to preventing the pine trees from widely dying of insect detection, silvicultural techniques and the integrated management of D. punctatus and M. alternatus should be enhanced.

INFLUNCE OF EUTOMOSTETHUS NIGRITUS XIAO ON THE GROWTH OF MOSO BAMBOO AND ITS CONTROL. Zhijian Zhu, Maozhi Wang, Yonghai Tu (Forestry Extension Service of Huzhou city, Zhejiang 313000, China), Sishan Xu (Forestry Extension Service of Deqing Coung)

E. nigritus is a major destructive insect of moso bamboo, and its larvae eat banbooleaves. The investigative results showed that the quality of new bamboos formed next year was affected obviously when the harm index was over 60, and the mean girth of brow height had a reduction of 6. 7 per cent to 12.9 per cent. The killing rate could raches 95.1 per cent, 91.7 per cent and 100.0 per cent respectively by spraying 0. 0005 per cent Deltamethrin, 0.0083 per cent Fenvalerate dimethoate and 0.02 per cent Dichlorvos on the larva of E. nigritus. In addition, the killing rate could also reche 98.7% per cent by injecting 50 per cent Tamaron (1.5 ml/plant) into bamboo cavity. it has achieved an outstanding result on bringing the reduction of girth of brow height under control since the above mentioned measures were taken.

THE DISCOVERY AND ECONOMIC IMPORTANCE OF ALIENICOLA OF KABURAGIA ENSIGALLIS. Ze-jun Tian, Xao-xiong Long (Sichuan Academy of Forestry, Chengdu 610066, China) Shu-min Xie, Xiang-lin Chen (Forest Brueau of Tongjiang County, Sichuan Province)

It is found that alienicolae of Kaburagia ensigallis popularly exist on their winter host moss, some of them becomes winged sexuparae and the rest develops to the adults of alienicolae in winter. The former ones emerged to be winged spring migrant bodies which are the resources of gallnut on the gallnut trees in the coming spring, meanwhile the adults begin to reproduct the same type of aliencolae on their winter host moss. It can multiple three generations from early February to mid-late May and the reproduction period can last to November. Kaburagia ensigallis is a kind of insect which has a double migrant and entire life story cycle. This discovery has a very important economic meaning to improving the management of gallnut production, widening the gallnut forestland and increasing the gallnut output.

STUDIES ON THE USE OF TAMARON FOR THE CONTROL OF BAMBOO INSECT PESTS. Maozhi Wang, Zhijian Zhu (Huzhou Station of Silvicultural Extention, Zhejiang 313000, China)

North of Zhejiang Province is a main bamboo-producing district. The bamboo forest is not only in large areas, but also has a concentrated distribution. In recent years, bamboo suffered damage by insect pests, such as, Algedonia coclesalis, Circobotys aurealis, Eumorphobotys obscuralis, Demobotys pervulgalis, Crocidophora evenoralis, Hippota dorsalis, Eutomostethus nigritus, Aiolomophus rhopaliodes, Otidognathus davidis etc. A large part of bamboo stands have withered and become chloratic, some bamboo even dided. This cause farmer's enormous economic losses. After testing for many years, it is clear that injecting Tamaron into bamboo cavity to control the various bamboo insect pests reached a mortality of over 95%. The residue of Tamaron in the bamboo shoots contained the highest amount on the tenth day after injection and gradually decreased day by day. The residue of Tamaron could not been found in the bamboo shoots coming out next year. Even the highest amount of the residue of Tamaron on the tenth day after injection is only 0.475ppm which is much lower than the standard for edible vegetable.

STUDIES ON THE RESISTANCE OF THE MASSON PINE CATERPILLAR TO INSECTICIDES, Yuan Ronglan, (Zhejiang Forestry College, LingAn 311300, China)

The masson pine caterpiller (Dendrolimus punctatus Walker) is the most important pest of the masson pine. It is widely distributed in southern of China. In the past, the insecticides such as BHC, DDT, Trichlofon etc. was frequently used in its control. Nowaday, the pyrethroids have been used in many places to replace the chlorinated hydrocarbon insecticides. However, owing to the abuse of insecticides, the problem of resistance is becoming a serious matter. The results of the laboratory tests showed that, in Lixai, Jinhua, Vanlin, Juzhou, etc., the resistance to Trichlorfon of the insect population had increased by 21.45, 26.07, 26.38, 27.98, 55.28 times compared with that of the insect population in Rongkang. In Jinyin, Rongcan, the resistence to the Decamethroin of the insect population had increased by 40. 38, 49.40 times campared with that of the insect population in Huangyin. The results also showed that there is a resistance at different levels according to the dosage used in different places.

STUDIES ON THE PARASITOIDS OF DENDROLIMUS PUNCTATUS WALKER IN ZHEJIANG PROVINCE. Zenqing Du, Lirong Sheng, Xuejing Qiu (Management Station of Forest Pest, Forest Bureau of Zhejiang Province, Zhejiang 310004, China)

Dendrolimus Punctatus Walker is one of the most important forest insect pests in China. The parasitism of its egg and pupal stage had been surveyed in Zhejiang Province during 1986-1989. 39 Hymenopterous parasitoids and 9 Dipterous parasitoids (13 egg parasitoids, 6 larval parasitoids and 29 pupal parasitoids) were found.

The average parasitism of egg was 17.7%, of which Telenomus dendrolimusi Chu; Trichograma dendrolimi Matsumura and Pseudanastatus albitarsis (Ashmead) were 8.95%, 4.25% and 1.83%, respectively. These 3 species were considered as the local dominate egg Parasitoids. The average parasitism of pupae was 15.84%, of which Blepharipa zebina (walker), Xanthopimpla pedator Fabricius and Brachymeria lasus (Walker) were 3. 82% , 2.30% and 1.30%, respectively. These 3 species were considered as the local dominate pupae parasitoids. The distribution of 48 parasitoids in Zhejiang province was also reported.

BIONOMICS AND CONTROL OF KERMES NAWAI KUWANA. Yue-yuan Lian (Zhejiang Forestry Research Institute. Hangzhou 310023, China)

Kermes nawai Kuwana is a major pest of Chinese chestnut, Castanea mollissima Blume. It hsa one generation a year and overwinters as the 2nd instar nymph on the 1 or 2 years twigs of Chinese chestnut tree in Zhejiang province. Male nymph pupated and female nymph developed into 3rd instar nymph in March next year. The emergence of male adult occurred in April. meanwhile female adult body expanded rapidly with the eggs in it developing and laid an average of 2000-3000 eggs per female. The first instar nympth was appearance in mid-May. The natural parasitism was about 38% . The best time for control was first instar nymph or early 2nd instar nymph and the mortality rate was 94.63-100% by spraying with " SN-851", mixed pyrethrin and dimethoate,methamidophos and omethoate which were diluted 1500 times water. Injected omethoate and " Sha Chong Shuang " which was as 1:1 and 1:2 to water into the trunk respectively. against Kermes nawai after its overwintering obtained 100% mortality. There was no pesticide residue in chestnuts with omethoate as 1:1 to water by trunk injecting method.

STUDIES ON THE POPULATION RATES OF TWO TRICHOGRAMMA WASPS PARASITED DENDROLIMUS PUNCTATUS WALKER FROM PINE WOODS, ARTIFICIAL PROPAGATION AND INOCULATIVE RELEASE IN ZHEJIANG PROVINCE. Zen-qing Du, Lirong Sheng, Xiu-jing Qiu (Management Station of Forest Pest. Forest Bureau of Zhejiang Province. Hangzhou 310004. China)

A investigation of the Trichogramma wasps parasitized the eggs of Dendrolimus punctatus for 11 sample counties of Zhejiang province was conducted during 1988-1989. It was determined that Trichogramma dendrolimi and T. confusum were 2 common parasitoids. their total population rates in 1988 were 86.85% and 13.15% in the sampled masses from the pine woods fields. respectively. The result showed that T.dendrolimi was the dominate species and the latter one only had partial dominance in few times and areas. the natural mixed specific competition was exist. The investigation on the parent wasp masses was conducted in the productive station. which showed that the population rates of T.dendrolimi and T. confusum were 14. 29% and 85.17% of the sample masses. respectively: The phenomenon of specific admixture was also exsit in the parent wasp masses. But the dominance of T. dendrolimi was increased and stablized through convert inoculating and propagating several generations on the egg of Antheraea pernyi: the population rates of it was 96.15% of the offspring wasp masses. The competitive experiment conducted in the pine woods fields had released artificial propagated Trichogramma wasp showed that 49.42% of the sampled masses was T.dendrolimi,

A STUDY ON THE DISTRIBUTION TREND AND POPULATION DYNAMICS OF TRICHOGRAMMA DENDROLIMI MATSUMURA IN ZHEJIANG PROVINCE. Hui-lang Fang, Pu-yuan Tong (Zhejiang Forestry Research Institute. Hangzhou 310023, China)

Trichogramma dendrolimi is an important egg parasite of forest pests. It breeds 17 to 19 generations each year under natural conditions in Zhejiang. Its population distribution hold predominance in pime forest of interior and low hilly area in Zhejiang province. but it is poor in pine forest of coastal area. Population dynamics of T. dendrolimi in different pinus massoniana stands have been obtained by using the method of hanging tussah ovum for attraction. The main conclusion is : the types of pine forest have a close relationships with the population density of T. dendrolimi and have no relations with the characteristic of population action: There are two action peaks of T. dendrolimi in the year cycle which lacate in May and September Lishui. Zhejiang. This is consistant with the egg stage of Dendrolimus punctatus Walker, it can play a control role to pest of pine forest.

STUDIES ON INSECT PESTS OF PINE TREES (PINUS SPP.) IN ZHEJIANG PROVINCE, CHINA. Xi-min Chai, Zhi-hua He (Zhejiang Forestry Institute, Hangzhou 310023, China)

128 species in 32 families of 6 orders which affected needle, shoot, cone and trunk of pine trees, Pinus massoniana, P. taiwanensis, P. thunbergii, P. taeda, and P. elliottii were recorded. The pine caterpillars, Dendrolimus spp. were major pests and outbreak in large area. Hyssia violascens Hamp. (Noctuidae) and Dasychira axutha Coll. (Lymantriidae) occured frequently and Nesodiprion zhejiangensis Zhou et Xiao and Gilpinia lipuensis Xiao et Huang (Diprionidae) have become serious insects in recent years. There were 15 species of cone insects on pine trees, of which Pyralidae and Tortricidae were abundant. The pine bast scale, Matsucoccus matsumurae spreads continually and the population of Aspidiotus cryptomeria Kuwana and Lepidosaphes pini (Mask.) (Diaspididae) increased yearly.

BREEDING FLY MAGGOTS IN CHICKEN-DROPPINGS TO PRODUCE PROTEIN FEED FOR DOMESTIC ANIMALS. Zizhan Huang (Dept. of Production Management, Bur. of Reform-Through-Labour, 33 Minzhu Rd., Nanning, Guangxi. 530023, China)

Making good uses of chicken droppings and pig or cattle excrements for artificially rearing fly maggots not only opens a new way to develop resources of animal protein feed in a developing country, but also reduces the pollution to the environment and benefit to the health of human beings.

During recent many years in Guangxi, China, we have got a series of experiments of raising the housefly in room (not in cage), for simplifying the equipments, procedures but harmless to fly-raising workers' health, increasing the productivity but decreasing the investment and the production cost.

We used the maggot-meal as a protein feed for livestocks(pigs), birds(chickens), and fishes(grass carps), comparing with the fish-meal through contrast test. As a result, the maggot-meal group is higher than the fish-meal group in body weight increased and protein efficiency, but cheaper in cost.

The achievement has been spreaded and applied in 10 provinces of China.

THE CONTROL OF HIPPOTA DORSALIS AND ITS APPLICATION IN PRODUCTION. Sishan Xu (Forestry Extension Service of Deqing County, Zhejiang Province, China), Zhijian Zhu, Yonghai Tu (Forestry Extension Service of Huzhou City, Zhejiang Province)

Hippota dorsalis (Stål) is found recently in bamboo forests of Zhejiang Province. It has brought serious damage to moso-bamboo forests. The result showed that putting Tamaron into bamboo poles is the best control method with a killing rate of over 95% if 1-2 ml of Tamaron is employed per bamboo culm. This control method had obtained remarkable economic benefit in production.

OBSERVATION ON THE BIOLOGICAL CHARACTER OF COCCYGOMIMUS DISPARIS (VICVECK) IN DALIAN DISTRICT. Yongcang Liu (Control and Qurantine Station of Forest Diseases and Insect Pests of Dalian, Liaoning 116001, China)

It was recorded that the Coccygomimus disparis was distributed in Korea, Japan, Soviet Union and China. In China, it was widely distributed except Guongdong, Guongxi and Xinjiang Province. It was reported the bodies that the insect lived were Dendrolimus tabulaeformis, Malacosma nellstria testacea etc.

The observation of C. disparis showed that the insect may propagated two times in Dalian in one year. Mature lara could overwinter in Cymantris dispar. In the middle of next May, the pupa appears. In early June, the adult grows up. The total times need 40 days. In late Aug, it begins to spend its "winter".

INTEGRATED CONTROL ON DIPRION LIUWANENSE HUANG ET XIAO. Yong-lin Sun, Liu-hua Qin (Bureau of Forestry, Guilin District, Guangxi 541001, China)

In Guangxi, D. liuwnense is one of the important pine pests. It has two generations per year. It overwinters under grasses, dead twigs and leaves with prepupae. This pest caused ecological damage. The integrated control measures on this pest were: 1. Cultivating trees within sealed-hill and reforming the components of forest, especial for the areas in which the damage often occurred; 2. Establishing the monitoring and forecastiong stations to get the information of weather, the population dynamics of pest and its enemies. Four investigations were made per year, when the pest was found, it should be controlled in time; 3. When the pest occurred in large areas, BT and beucophenel ureas were used to decrease the pest densities, or toxic rings were smeared on tree stems in the late of October; 4. The last method was preserving and artificial releasing pest enemies such as birds and egg parasites.

A STUDY ON GILPINIA MASSONIANA. Jin Shi, Ping Liu (The General Forest Protection Station of Anhui Province, Hefei 246000, China), Guangyu Zhu (The Forest Protection station of Chuxian Region, Anhui Province, China)

Gilpinia massoniana broke out in Changchong Forest Farm of Chu County, Anhui province. Its major host is Pinus massoniana. According to the survey conducted in the May of 1991, the area infested by the pest was about 9,000mu. The pest has 2 generations per year. It pupates under the litter, in the root part of grass and in the soil from the middle of June to early July and from later October to the middle early of November, and aestivates and hibernates by prepupae. The larva has 6 instars, feeds an average 573.1cm of the pine needles during the period of the 1st-5th instars. After entering into the 6th instar, the larva feeds nothing and pupates in 5 hours to 2 days. The sex ratio of the adults is 1:1. After mating, the female lays the eggs on the needles, the average product of eggs per female is 87.6. It majorly distributes in the pure Pinus massoniana's forest of 20-30 years old, especially in the sparse forest and the forest edge. The pest can be effectively controlled by 10% Fenvalerate or 10% Mevinphos.

STUDIES ON THE SEASONAL DISTRIBUTION LAW OF MONOCHAMUS ALTERNATUS HOPE IN THE INFECTED PINE FOREST. Xiao-yun Wang(Anhui Forest Biological Control Center, Hefei 230001, China)

Monochamus altenatus Hope is the major vector of the pine wilt disease (Bursaphelenchus xylophilus) and has one generation each year in Anhui Provine. A serial research for three years, including periodical monitoring, investigation, sampling and identification, has been done in the infected pine forest of the Province. It has been proved that the wilted trees occuring from June to October in the year, which account for 70% of the total of the wilted in the year, have a 100% of the borer percentage and those occuring from November to May next year, which account for about 30% of the total, have the lowest percentage (zero). It is considered that the intensive cutting and the strict control treatment before using should be done on the former during September to October in the year for controlling the spread of the pest. As for the latter, the cutting work could be done during November to May next year and the cut trees could be directly used for the processing of products after stripping barks off, dispensing with the treatment. It could be also retained in the forest ,and used for the natural lure which could attract the egg-laying adults. The research has provided a new means to solve the problems such as the shortage of funds and labour forces for the control of the disease.

CONSTRUCTION AND ANALYSIS ON LIFE TABLE OF THE PINE SHOOT BEETLE, TOMICUS PINIPERDA (L.) POPULATION. Hui Ye (Institute of Ecology and geobotany, Yunnan University, Kunming 650091, China) , Zhi mo Zhao (Department of plant protection, southwest Agriculture University, Chongching 630716, China)

On the basis of a research made in different harmful phases of the pine shoot beetle, the life table of pine the pine shoot beetle population was constructed in this paper. The life table shows that the main death factors of the pine shoot beetle population are intraspecific competition, the pine resin, parasitoids, predators and the other unknown factors. In these factors the fatality rate of intraspecific competition is the largest, 39.85%. The pine resin get the second place in the influence on the shoot beetle population and the fatality rate is 20.59%. The fatality rate of unknown factor is 13.37%, which includes temperature, humidity, etc. From the analysis on the different life stages, the larval death rate is the highest, 52.38%; the adult death rate is in the second place, 15.5%; the egg and the pupa death rate are 5.8%, 2.7% respectively. Currently the index of the pine shoot beetle population trend "I" is 11.42.

OBSERVATION ON PINE SHOOT BORER OF LOBLOLLY PINE AND ITS CONTROL. Ping Liu (The General Station of Forestry Pest Control of Anhui Province, Hefei 230031, China), Guang-Yu Zhu (The Station of Forestry Pest Control of Chuxian County, Chuzhou 239000, China).

Dioryctria rubella and Petrova cristata are serious pests that damaged the twigs of Pinus taeda in Dinyuan County of Anhui Province. Their young larvae damaged bud and make it withers. The 2nd and 3rd instars of larvae bore the tender branches, cause the new growth withers. The harmful period of them was from May to November. The damaged rate was 8% in June and July, and reaches the peak of 16% in august and September. They could not be effectively controlled by spraying fenvalerate phosphamidon and phosalone. Cutting of the infested twigs manually was a effective method.

INFLUENCE OF TEMPERATURE ON THE EXPERIMENTAL POPULATION OF THE PINE SHOOT BEETLE, TOMICUS PINIPERDA L. Hui Ye (Institute of Ecology and Geobotany, Yunnan University, Kuming 650091, China)

The present paper deals with the relationships among the temperature and the development, survival, reproduction of the pine shoot beetle, Tomicus piniperda L. at five constant temperatures from 10-30℃ . The threshold temperature and resistance of the beetle to minimum and maximum temperatrue and also studied. The development rates of egg, larva, pupa are increased with temperature from 10-30℃. For these stages the threshold temperature were calculated to be about 8.23, 7.2, 7.85℃, and the thermal constant required for the developments were 95.8, 358.12, 115.87 D(day-degree) respectively. The survival rate reach maximum in 20-25℃, and decrease in higher or lower temperature. The pine shoot beetle can stand at the low temperature around -5℃, but can not survive when the temperature is higher than 35℃. The egg number reproduced by one female a day and the tunnel length constructed a day increase with temperature at 10-25℃. At 25℃ the egg number per female lay a day is about 6. The egg density reaches the maximum in egg tunnel at 15℃.

A STUDY ON SCHLECHTENDALIA CHINENSIS (BELL) FOR PRODUCTION OF CHINESE GALLNUT. Yong-qi Lai (The Research Institute of Resource Insect, Chinese Acadamy of Forestry, Kunming 650216, China)

Chinese gallnut caused by Schlechtendalia chinensis (Bell) possesses high economic value. It has just been cultivated from the wild. Naturally, only a few aphids leave the gall to their winter hosts, some mosses. Owing to its heredity low temperature, rain and water in the moss layer, the number of the aphid is reduced sharply by the end of the coming out generation from the gall. There is a relation positive between the gall and the aphid. The key of producing the gall is to raise a large number of the aphids causing the gall by taking some effective measures, such as increasing the moss and setting the aphids on it and creating an environment suitable for the aphid in the gall woodland.

A PRELIMINARY STUDY ON THE INSECT IN HUPINGSHAN NATURE RESERVE. Guangchun Lei, (Forestry Department of Hunan Province, 39# Nanda Road, Changsha, Hunan 410007, China)

Hupingshan Mountain, located at the northwest Hunan, is the summit of the province with the elevation of 2,098.7 metres, the max. relative height difference of 1,847.7 metres (the bottom's elevation is 251 metres) , and the main body of Hupingshan Nature Reserve with the total area of 40, 000 hectars where covers with beautiful oringinal and secondary forests. To preveal the mystery of this region, a intergrated study on insect was conducted from May to July in 1987. 4,145 species, belongs to 24 orders, 264 families, were reported from the study, in which 1 new genera and 31 new species were named. The fauna analysis in five families indicated that the region is a typical meeting point of the realm of paloearetic and oriental, 48.33%, 20% and 28.75% of the species are belongs to paloearetic, oriental and both of them respectively. The study of insect community and its vertical distribution indicated that there are two communities are very special and the structure of the community varied remarkably with the change of elevation and its mico-ecosystem.

INTEGRATED MANAGMENT FOR STEM-BORE PESTS ON POPLAR IN THE PLAIN OF JIANG-HAN. Guozhuo Jiang (Jianli Forestry Protection Station. Hubei 433300, China)

Apriona germari (Hope) and Batocera horsfieldi (Hope) heavily affected early and following development stages of poplar respectively. The integrated measures to control the two pests were: 1. Reforming old-forest in order to eliminate pest. The segregate forestbelt were planted health and strong pest-resistant varieties beside forest of elm and mulberry, carefully forsterd and pruned at right time; 2. Protecting and releasing insect enemies and pest-eaten birds to control pest damage, exploited to use bacteria, fungi and viruses in controlling program: 3. Capturing and killing adults and blocking up adult emerging holes on time: 4. Putting the pieces of chemical wood in pest holes to kill the larvae.

DUSTING BEAUVERIA BASSIANA'S SPORES BY MINI-DUSTER TO CONTROL BORER. Guoqing Xu (Forest Protection Station, Shuizhou Forest Bureau, Hubei 441300, China)

This paper first covered applying mini-duster designed by author directly to dust B. bassiana into insectholes of Aproina germari Hope and Batocera horsfield Hope, the control effect reached 95-100%. There were 120 billion spores per gram, which killed 300 larvae and only spent 0.0002 Chinese yuan. The method had an advantage of low cost, good efficiency and no environmental pollution. The mini-duster could also dust chemical powder such as benzene hexachloride.

A STUDY ON BIOLOGY AND CONTROL OF BATOCERA HORSFIELDI HOPE. Zhu Xue, Changren Lu, (Hubei Forestry School. Wuchang county 430200, China)

Batocera horsfieldi occurs in Hubei province. It is the main pest of Populus deltoides Marsh I-63, I-65 and Populus x Euramericana I-72 etc. Its damage to the poplars becomes more and more serious. It has one generation in 2 years, and overwinters as larva or adult in the borering path and pupal cell. Its adult eats the new growing bark, the larva bores the phloem and xylem, breaking off the stem and tip and decreasing the utilization value of the wood. We have made plant quarantine, cleared insect source, set up isolation strip, afforested and mixed forest, injected Beanveria bassiana or pesticide and plant alkaloid into the hole to blocked it, hammered the eggs and caught the imagines by hand. All these measures obtained effective control. Qobius sp. and Dastarcus logulus Sharp are the natural enemies of Batocera horsfieldi, we should try to protect them.

INTEGRATED MANAGEMENT OF PINE CATEPILLARS BASED ON LIFE-TABLE STUDIES. You Youlin (Agrometeorological Institute, CAAS, Beijing 100081, China), Wu Yi(Department of Forest College, Kunming 650000, China)

Pine caterpillar is one of the most destructive pests in conifer forests in China. The biological and ecological characteristics of *Dendrolimus Kikuchii* Mats. and other three species occurring in Yunnan, southwest of China, have been closely investigated. The key-factor analysis based on their life-table data has been made to help formulate population trend predictions. The pest management strategy and tactics have been formed and implemented during a five-years project with promising results. We are convinced that the regular population monitoring is important in IPM and it should be restricted to infestation centers. The main points of the IPM for Yunnan forest regions are as follows: (1) Regular pest population monitoring aiming in locating infestation sites. (2) Holding the over-wintering population in check by applying the microbial pesticides wherever humidity allows in early spring time. (3) Limited use of the selective chemical pesticides and other means including manual practices may be considered.

STUDY ON THE CORRELATION BETWEEN THE DAMAGE OF TRUNK BY XYLOTRECHUS CHINENSIS AND THE LOSS OF MULBERRY LEAVES. Zhigang Wang, Junjie Yan, Dianrong Ji (Hebei Forestry College, Baoding 071000, China)

Xylotrechus chinensis, which was a destructive borer to mulberries, caused great loss in mulberry fields in north China in recent years, and the damage rate reached 65.42%. The damage rate was only a quota for trunks, the study was an attempt to exchange the damage of trunk for the loss of mulberry leaves to show the influence of the pest on the production and economic profits of mulberries. Analysis of the diameter of the damaged trunks showed there was significant possitive correlation between the diameter (from 7cm to 12cm) and the loss of the leaves and the output of the leaves has significant difference between the damaged plants and the health. Statistics based on the divisions of diameters showed the average damage rate was 31.4% and the average loss of mulberry leaves in a year was 2962 g/plant. For the same plant, the loss of the damage branches was 52.8% compared with the non-damaged branches with the same diameters. Based on the above results, the loss of one plant was 0.9 yuan. In north China, there are about 200 million plants of mulberries, so the direct loss are about 117 million yuan. Therefore, it is an important problem demanding prompt solution to control the damage of X. chinensis in mulberry fields.

INVESTIGATION ON FOREST PLANT DISEASES AND INSECT PESTS DISTRICT AND SYSTEM IN DALIAN CHINA. Peilian Zhao (Dalian Forest Quarantine Station, Liaoning 116001, China)

Through investigation on the species, parasitism and distribution of forest insects in Dalian for six years, totally 1,687 Species of insects, belonging to twenty orders and 184 families.

Utilizing the investigation materials and the viewpoint of ecology, according to the relation between the forest insects and topography, landforms, climate condition, the flora and fauna and forest development and replacement, and also according to the theory on geographical divisions of insects in China, the division of insects in Dalian area has beeen defined. In China, it is subordinate to the Northeast Region and its filiation is the most familiar with North China Region. The division further expounds and proves the unity between the insect district systerm and the flora. It also expounds and proves that the forest insect district system changes with the changes of the topography, landform and climate conditon. And it further proves the unity between the forest insect and the enviroment

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ENVIRONMENTAL MANAGEMENT OF VECTOR MOSQUITOES. V.P. Sharma (22-Sham Nath Marg, Delhi-110054, India.)

Vector control in India has become difficult and unattainable inter alia due to insecticide resistance and operational problems. As a result endemicity to malaria has not changed, filaria is entering into new areas, and dengue and JE epidemics have become more common and pronounced. Studies on environmental management of mosquito breeding to control malaria in endemic areas revealed that it is a rational approach to interrupt malaria transmission and reduce mosquito nuisance. Results of field experience would be discussed highlighting the importance of health education, community participation and inter and intra-sectoral coordination in achieving the vector control objectives.

METHODS FOR CONTROLLING MALARIA AND FILARIASIS VECTORS WHICH ENCOURAGE COMMUNITY PARTICIPATION. C.F. Curtis (London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, U.K.)

In many tropical countries centrally organised spraying programmes against vectors do not now receive sufficient funding and have become unpopular with communities. However, householders are generally concerned about mosquito nuisance and malaria risks and may spend considerable proportions of their income on relatively ineffective anti-mosquito measures such as domestic aerosol cans and smouldering coils. Much more cost-effective methods have now been widely tested, including pyrethroid impregnated bednets or curtains and application of floating layers of expanded polystyrene beads to suppress mosquito larvae in pits and tanks.

Tanzanian communities have participated enthusiastically in the application of both these methods and substantial reduction in vector populations have been recorded. If these methods are to be widely applied consideration needs to be given to funding the necessary supervision and initial capital costs.

EVALUATION OF BEDNETS IMPREGNATED WITH PERMETHRIN FOR CONTROL OF ANOPHELES DIRUS TRANSMITTED MALARIA IN HAINAN ISLAND. Li Zuzi Pan Bo, Zhang Mancheng, Luo Kunming (Institute of Anti-parasitic Diseases of Guangdong Province, Guangzhou, China. 510300) Li Mingxing (Institute of Tropical Diseases of Hainan Province Haikou, China. 521000)

A field trial of permethrin-impergnated bednets for the control of malaria transmitted by An. dirus was carried out in Beida District, Hainan Island. From April 1989 to March 1990, the pre-trial baseline data on malaria epidemiology was obtained in study area and control area. There are populations of 6248, 75.4% of them owned nets, 98.2% of these were impregnated once a year at the dose of 500mg ai/m² in April of 1990 and 1991 in the study area. The density of the human baits at the peak of seasonal prevalence (May to September) was 47 before treatment and it dropped to 19 and 10 after treatment in 1990 and 1991, a decrease of 57.6% and 78.9% compared with the same periods in 1990 and 1991, respectively. In the control area the corresponding catches were 33, 74 and 40 respectively. The mean monthly malaria incidence between May to October was 10.45‰ in the study area before treatment and it dopped to 4.43‰ and 2.20‰ during the same periods after treatment in 1990 and 1991. Before treatment (May to October) 43.1% the infections were Plasmodium falciparum, but it dropped to 6.6% and 24,1% in 1990 and 1991 after treatment. In the control area, the corresponding figures were 3.33‰, 3.96‰ and 4.94‰.

THE CHALLENGE OF MALARIA VECTOR CONTROL IN AFRICA. J. Mouchet (59, rue d'Orsel, 75018 Paris, France)

Tropical Africa is an enormous focus of *falciparum* malaria (90% of the cases in the world) transmitted by *Anopheles gambiae* and *An. funestus*. In West and Central Africa the disease is highly stable. On the Sahara border, in mountains and the Southern part of Africa it tends to become unstable.

In areas of stable malaria, larval control has a neglictible impact on the disease incidence. In the past, house spraying had little efficiency in savanna but gave a good control in forest areas. Nethertheless in this last environment the disease jumped to its pretreatments level as soon as the spraying ceased. Pyrethriod impregnated bednets are promising but their use at community level has to overtake the social and economic constraints.

In unstable areas e.g. mountains of Burundi, Plateaux of Madagascar, lowveld of Swaziland, DDT house spraying has given good control. Larval control can only be envisaged in a limited number of cases e.g. Wells of Somalia desert.

Apart technical aspects, vector control is empeded by the lack of funding and mainly depends on outside contributors because the endemic African countries are among the poorest of the world.

ECOLOGY OF *ANOPHELES SINENSIS*. Tong-yan Zhao, Bao-lin Lu (Institute of Microbiology and Epidemiology, 27 Taiping Road, Beijing 100850, China.)

An. sinensis is the most common and widely distributed anopheline mosquito in China. A lot of work has been devoted to this species, however, the early studies might be mixed with *An. anthropophagus*, which was not differentiated until 1960s. At present knowledge, *An. sinensis* has the following ecological features: (1) It breeds in various standing waters, including the vast areas of ricefields; (2) It is mainly zoophilic, attacking cattle, pigs, horses and other livestocks, but also invades into house for sucking human blood. Though it is a less efficient malaria vector, it can maintain a low endemicity of the disease in rice cultivated flatlands. The large breeding grounds and ample food sources result in a large population size of adults in many areas. (3) It is exophilic to a certain extent in different areas. (4) It has a nocturnal type of biting cycle. (5) In seasonal distribution, it shows a single peak in rice cultivated areas of one-crop for a year and two peaks in double-crop regions. (6) It overwinters in a state of quiescence in adult stage in temperate and north temperate regions.

With these features, the control of *An. sinensis* is a very difficult problem in China. In most villages, residual sprays with DDT or other insecticides in stables and the use of pyrethroid-treated bednets could be suggested.

MOSQUITO CONTROL IN RICE FIELDS. M.V. Meisch (Department of Entomology, 321 Agriculture Building, University of Arkansas, Fayetteville, AR 72701-1201, USA)

The primary goal of the Riceland Mosquito Management Program is to direct a coordinated, multi-institutional, multi-disciplinary research effort toward gathering the scientific knowledge necessary to develop and implement integrated pest management (IPM) schemes designed to maximize the use of non-chemical methods to effectively suppress mosquito populations associated with irrigated cropping systems in the United States. Mosquito populations breeding in such systems are among the most likely targets for the immediate application of IPM schemes since they have adapted themselves to habitats which are already largely under the control of man and schemes he has developed to manage his land and have become rather dependent upon man and his activities for their continued existence in these agroecosystems. It is, therefore, proposed that these particular mosquito populations can be effectively suppressed by the development of IPM schemes involving strategic modification of crop management practices augmented with other approaches designed specifically for mosquito suppression and the integration of these schemes into crop management programs in such a manner that the land is rendered unsuitable for mosquitoes, yet highly productive from the standpoint described herein will be directed. It is to these ends that the research program described herein will be directed.

INTEGRATED MANAGEMENT OF RICEFIELD-BREEDING MOSQUITOES. Bao-lin Lu (Institute of Microbiology & Epidemiology, 27 Taiping Road, Beijing 100850, China.)

The vast areas of ricefields in China are the important breeding grounds of *An. anthropophagus, An. sinensis* and *Cx. tritaeniorhynchus*. The former two are the important vectors of malaria and Brugian filariasis and the latter, main vector of Japanese B encephalitis.

Three approaches were adapted for the control of these ricefield breeders: (1) Wet irrigation method: Immediately after the recovering of the transplanted seedlings, water is drained off from the fields, then supplied according to the needs of plants. Fields are intermittently flooded to a shallow depth. The method has the advantages of effectiveness of larval control, increase of rice yields and save of irrigating water. The method was practiced in yellow River and Hai River basins. (2) Pisciculture: The farmers are encouraged to rear domestic fishes by the Ministry of Agriculture. It was found that the larval density could be reduced over 60% in ricefields with fishes and the yields of rice could also be increased. (3) Treated bednets with pyrethroids, particularly with deltamethrin. Millions of bednets were treated in these years. The treated nets increased the protective effects through the toxic and excito-repellent effects on mosquitoes rested on them. The method has been adapted in the antimalarial programmes in China.

APPLICATION OF RECOMBINANT DNA TECHNOLOGY IN MOSQUITO MANAGEMENT. Paul Eggleston, Gareth Lycett, Ann Warren, Iain Comley, Teresa Knapp and Julian Crampton. (Wolfson Unit of Molecular Genetics, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, U.K.)

Diseases transmitted by insects, and particularly by mosquitoes, pose some of the most serious health care problems in the World today. Existing measures for the control of insect borne disease rely on the application of chemical insecticides. However, the inevitable evolution of resistance, together with the cost of developing and registering new insecticidal compounds and growing environmental concern over their use, has emphasised the need for long term alternatives. The aim of the research described here is to exploit the potential of recombinant DNA technology in the development of novel disease control strategies, either by suppressing the insect which acts as the vector or by compromising its ability to transmit pathogens. In order to achieve this goal, we need to improve our understanding of the molecular biology of mosquitoes and target those genetic systems which may have relevance to future integrated pest management strategies. This will require appropriate systems for the isolation and characterisation of the genes involved, together with transformation techniques which enable modified sequences to be manipulated within the mosquito genome. Ultimately, the efficacy of this technology will need to be tested in both laboratory and natural populations. Although there are many technical and perhaps ethical problems to overcome, the potential of this technology for the control of insect borne disease demands that it be pursued. Here, I shall describe some aspects of the progress which we have made towards mosquito genome manipulation through micro-injection of embryos and transfection of cell cultures.

Dengue Hemorrhagic Fever: A Global Update. ***Duane J. Gubler, Sc.D.***
Director, Centers for Disease Control, Division of Vector-Borne Infectious Diseases, PO Box 2087, Fort Collins, CO 80522

Dengue is the most important arbovirus disease of humans. It occurs in a belt around the tropics of the world with over 2 billion persons at risk of infection. Each year there are 10s of millions of cases of dengue fever and 10s to 100s of thousands of cases of the severe and fatal form of disease, dengue hemorrhagic fever (DHF), depending on the year. The epidemiology and disease pattern associated with dengue infection changed dramatically during the decade of the 1980s. In Asia , the DHF distribution expanded into Sri Lanka, India and the Maldive Islands to the west and into China and Taiwan in the east. DHF occurred in epidemic form in the Americas for the first time in 1981. Since then, 12 countries have reported confirmed DHF cases. By the end of the decade, the American tropics had become a hyperendemic area; the disease pattern evolved there in the 1980s much as it did in southeast Asia in the 1960s. In summary, the 1980s provided ideal conditions for the increased movement and spread of dengue viruses in all tropical parts of the world where *Aedes aegypti* mosquitoes were present. This resulted in increasingly more frequent and larger epidemics, and a dramatic increase in the incidence of DHF. In the decade of the 1980s, there were 3 times more cases of DHF reported than in the previous 25 years. Without more effective strategies for prevention and control, the 1990s will bring a further increase in the incidence of DHF.

Lack of Efficacy of ULV for control of *Aedes aegypti*
I.P. Reiter, Dengue Branch, Centers for Disease Control, Division of Vector-Borne Infectious Diseases, PO Box 2087, Fort Collins, CO 80522

Aedes aegypti is the principal urban vector of dengue and yellow fever. In the past, great efforts were made to reduce transmission by eliminating breeding sites and by the use of residual insecticides. In the past 20 years, public health authorities have increasingly relied on aerosol adulticides, particularly Ultra Low Volume (ULV), applied from road vehicles or airplanes. In a long series of collaborative trials in Puerto Rico, Jamaica and Venezuela, using two improved methods for monitoring adult populations, we have consistently failed to demonstrate more than a minimal, ephemeral effect on female *Ae aegypti* populations. These results corroborate studies in Trinidad and Surname. Our laboratory has quantified the preference of this species for secluded, indoor refuges, and the inability of ULV aerosols to penetrate such sites. On the basis of the principles of air movement in small buildings, we interpret the lack of efficacy of ULV in terms of house structure and ventilation. Moreover, using a model of dengue transmission, we conclude that ULV treatments are unlikely to have a useful impact on disease prevalence, even at much higher rates of control than we have observed in the field. Lastly, we have analyzed costs on a per hectare basis, including capital outlay and all other parameters associated with the maintenance of a ULV program. We conclude that from the economic, as well as the entomological and medical perspectives, there can be little justification for utilizing resources for a non-residual adulticiding method for the control of *Ae. aegypti*.

DENGUE VECTORS AND THEIR CONTROL IN CHINA. Bao-lin Lu (Institute of Microbiology & Epidemiology, 27 Taiping Road, Beijing 100850, China.)

The vectors of dengue had not been studied until the outbreak of the disease in Foshan, Guangdong Province, in 1978. Since then, through dengue virus isolations and experimental infection and epidemiological studies, *Aedes aegypti* was found to be the main vector of DF / DHF in Hainan Island and also in several parts of Guangdong and Guangxi Provinces. *Ae. albopictus* was responsible for the epidemics in Guangzhou and Foshan.

Source reduction was emphasized for the control of both species. For *Ae. aegypti*, as it mainly breeds in water containers for drinking and other domestic use, in addition to the environmental management, biological control methods, including liberating fishes or / and adding *Bacillus thuringiensis* serotype H-14 into water containers, were practiced. This integrated management was found to be very effective for the control of this domestic species. For instance, in an experimental area highly infested by *Ae. aegypti* in Hainan Island in 1989-1990, the Breteau index was kept below 3 through the implementation of these methods. A more encouraging result was reported from Guangxi Province. It was claimed that *Ae. aegypti* was completely eradicated in seven spots of the province through the continuous use of fishes in water containers.

For the peridomestic *Ae. albopictus*, besides biocontrol agents, chemical larvicides, such as slow release formulations of abate, were also used for the control of larvae bred in old tires, water containers, rock pits, etc.

COMMUNITY-BASED AEDES AEGYPTI CONTROL IN THAILAND. P. Kittayapong (Dept. Biol., Fac. Sci., Mahidol Univ., Bangkok, Thailand), D. Strickman (Dept of Entomol., Armed Forces Res. Ins. Med. Sci., Bangkok, Thailand), and B.L. Innis (Dept. Virol., Armed Forces Res. Ins. Med. Sci., Bangkok, Thailand)

A pilot project on community-based, integrated Aedes aegypti control was initiated in 1991 in a rural community located 80 km east of Bangkok, Thailand. The control applied by local residents included mechanical, chemical (salt and oil), and biological techniques. All materials were cheap and locally available. Community participation was achieved by 1) associating dengue and vector control education with traditional events, 2) developing vector control organization in the community, 3) encouraging local government involvement. The program was evaluated by weekly landing/biting counts, weekly ovitrap egg-counts, periodic larval surveys, and sero-survey of children at the end of the peak season of transmission. After six months of the control program, a clear reduction of the Ae. aegypti population was observed in the treated village and school compared to untreated areas. In the village, the landing/biting rate was reduced by 68% and the Breteau index by 72% (from 539 positive containers per 100 houses to 150). The landing/biting rate in the treated school was reduced by 86%. Although transmission in 1991 was generally low (2.3% seroconversion against dengue measured in September), we observed a significant difference between the untreated (14 of 428 students) and treated schools (1 of 237 students).

BIOLOGY AND BEHAVIOR OF AEDES ALBOPICTUS IN THE AMERICAS. Leonard E. Munstermann (Department of Epidemiology and Public Health, Yale University School of Medicine, 60 College Street, New Haven, Conn. 06510, U.S.A.)

The Asian Tiger Mosquito, Aedes (Stegomyia) albopictus, was discovered in North America in 1985. From seaport foci in southern Texas and Louisiana, this mosquito has spread over most of the eastern USA. By biochemical profiles, physiological responses, and typical larval habitat, its probable origin was central Japan. Aedes albopictus has also been introduced in southern Brazil; however the origins of this rapidly expanding infestation have not been determined.

Aedes albopictus is evolving its physiology to match its new environment. The north-south cline of diapause induction in response to photoperiod is taking on the shape of the response curves seen in its native temperate habitat in Japan. In addition, it appears to be displacing a related Stegomyia, Ae. aegypti, in nearly every locality where the two species come together—possibly due to the Albopictus larval gut parasite, Ascogregarina taiwanensis, which has debilitating effects on Ae. aegypti larvae. Its changing physiology and movement in southern Florida indicate a strong potential to colonize tropical America.

In the Americas, the Albopictus threat to human health remains hypothetical. However, laboratory-induced infections by such arboviruses as dengue-hemorrhagic fever, St. Louis encephalitis and California group viruses develop and are transmitted readily by Ae. albopictus. Furthermore, in 1991, eastern equine encephalitis virus was recovered from 14 of 90 pools (~100 Ae. albopictus each), field-collected in south-central Florida.

TRANSMISSION DYNAMICS OF MOSQUITO-BORNE DISEASE. C. Dye (London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK.)

I am concerned in this paper with the problem of how to measure parasite transmission rate by bloodsucking insects, especially mosquitoes. The main conclusion is that measurements made on vector populations are primarily of comparative rather than absolute value. In reaching it, I shall:

1. distinguish between the qualitative and quantitative significance of Vectorial Capacity,
2. discuss thresholds in malaria and filariasis, and the best way of estimating Basic Reproduction Number,
3. comment on the relative advantages of measuring intensity and prevalence of infection in mosquitoes and on the accuracy of immunoassays,
4. consider the motives for studies on vector-parasite interactions, and
5. question the relationship between entomologists and parasitologists.

EFFECTS OF SUBLETHAL DOSAGES OF PYRETHROIDS ON THE PREIMAGINAL DEVELOPMENT AND THE FECUNDITY OF VECTOR MOSQUITOES. Jin-tong Zhang,Rui-de Xue, Rong-man Xu, and Bao-lin Lu (Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, Chnia)

The effects were studied of sublethal dosages of two pyrethroids, deltamethrin and alphapermethrin on the preimaginal development and the fecundity of four species of vector mosquitoes, i.e., *Culex pipiens pallens, Cx. tritaeni orhynchus, Aedes aegypti* and *Anopheles dirus*. The results showed that the sublethal exposure of mosquito larvae to the pesticides may greatly reduce both the rates of pupation and emergence, whereas have no significant influence on the fecundity, including blood feeding, oviposition and egg hatching, of the females which survived the exposure. On the other hand, a dramatic reduction of feeding rate was observed after the females suffered from a sublethal treatment. Although the sublethal attack on the adult mosquitoes give no definite effects to the oviposition and longevity, the proportion of scattered eggs (for culicine) increased, and the hatching rate of eggs was reduced significantly compared with that laid by the control groups.

BLOOD-FEEDING BEHAVIOR OF AEDES AEGYPTI IN RELATION TO DENGUE VIRUS TRANSMISSION

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USA

The nature of Aedes aegypti-host interactions and the role of that interplay in the transmission of dengue viruses are reviewed. Longitudinal studies in rural Thailand and urban Puerto Rico are summarized. Data on blood-meal analyses, histologic studies of engorged mosquitoes, and dissections of unengorged mosquitoes are used to demonstrate that Ae. aegypti blood-feed frequently in each gonotrophic cycle and that frequent blood-feeding is an important factor in the persistence and dynamics of dengue virus infections in humans.

DISPERSAL AND FOCALITY OF AEDES AEGYPTI

IN A DENGUE FOCUS IN THAILAND

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Mark-recapture methods were used to study dispersal and local movement of released populations of Aedes aegypti in a rural Thai village. Dry and wet season patterns are compared and results related to house resting behavior, the seasonality of dengue transmission, and the clustering of human cases within villages. The behavior of large- and small-bodied individuals and of sugar-fed and sugar-deprived mosquitoes is compared.

THE ENERGETICS AND SURVIVAL OF MOSQUITOES IN THE FIELD. Jonathan F. Day, Emile van Handel (Florida Medical Entomology Laboratory, IFAS/University of Florida, 200 9th St. SE, Vero Beach, Florida 32962)

Sugar, in the form of nectar and honeydew, is an important source of energy for mosquitoes in the field. Colonized and field collected mosquitoes maintained in the laboratory need a source of sugar to insure survival. Mosquitoes in the field acquire and utilize sugar differently than do conspecifics maintained in the laboratory. In general, laboratory mosquitoes supplied with an unlimited source of sugar produce maximum glycogen and lipid reserves. Field mosquitoes seldom produce the levels of glycogen or lipid observed in the laboratory. Because survivorship, biting, egg laying, and disease transmission are closely tied to the energetics of adult mosquitoes, it is important to understand how they obtain and utilize sugar in nature. In this paper we present field data on the adult energetics of four important mosquito species; *Aedes aegypti, Aedes albopicuts, Aedes taeniorhynchus,* and *Culex nigripalpus*, collected in the field in Florida, USA and discuss how the nutritional ecology of adult mosquitos may influence disease transmission cycles in nature.

PHYLOGENIES OF VECTOR COMPLEXES: WHAT CAN THEY TELL US?

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Cladistic methods are important in studying vector-pathogen interactions. Analysis of evolutionary relationships of the subgenus Melanoconion of the genus Culex which includes the vectors of Venezuelan equine encephalomyelitis and South American strains of eastern equine encephalomyelitis viruses, using cladistic methods are presented. The information generated from phylogenetic trees is used to discuss mosquito-virus evolution.

XIIS-3 Mosquito Biology, Genetics, Vector Competence and Relationship to Disease Transmission

ANOPHELES HYRCANUS GROUP OF CHINA. Bao-lin Lu (Institute of Microbiology & Epidemiology, 27 Taiping Road, Beijing 100850, China.) Wan-ming Kang (Sichuan Institute of Parasitic Disease Control, Chengdu 600041, China.)

An. hyrcanus group is the most important and complicated species complex of China. Eight new species were described since 1976 and brought the total number of the group to 18 species. However, through the light of cytogenetic and hybridization studies, only 13 species seem to be genetically isolated.

Among the group, *An. anthropophagus* and *An. sinensis* were discriminated as vectors of malaria and Brugian filariasis in China. Experimental studies showed that both species were susceptible to *Pl. falciparum* and *Pl. vivax*, but the susceptibility of *An. sinensis* was much lower than that of *An. anthropophagus*. In fact, the latter species was responsible for the *Pl. falciparum* cases in central and eastern China.

The two species were equally susceptible to *Brugia malayi*, but owing to its anthropophilic in host preference, *An. anthropophagus* is an efficient vector for both malaria and filariasis. In fact, it plays a more important role of malaria transmission than that of *An. minimus* south of 25 ° N at present.

A recent report claimed that *An. kumingensis* had a high sporozoite rate in certain parts of Yunnan Province and was discriminated as a new malaria vector in the *An. hyrcanus* group, but it was showed that it could mate with *An. liangshanensis* in hybridization studies.

MECHANISMS OF REFRACTORINESS IN ANOPHELES, THEIR INTRODUCTION AND PARASITE RESPONSE. C.F. Curtis (London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, U.K.), A.M. Feldmann(ITAL, Box 48, Wageningen, The Netherlands), and P.F. Billingsley (Department of Biology, Imperial College, London SW7 2BX, U.K.)

Methods are considered for introduction into wild Anopheles populations of genes for non-susceptibility (refractoriness) to Plasmodium malaria parasites. Such an introduction would place strong selection on the parasite to evolve means of evading the effects of the introduced genes. Such evasion would be less likely if two or more independent "blocks" to Plasmodium development were introduced so that only double mutants could evade both blocks and be successfully transmitted. Thus identification of the mechanisms of refractoriness is of more than academic interest. Two mechanisms of refractoriness to P. falciparum have been selected in Anopheles species. Increased aminopeptidase activity and early onset of haemoglobin degradation in the midgut of A. stephensi were correlated with refractoriness to P. falciparum ookinetes, which did not invade the midgut wall (Feldmann et al., Parasitology 101:193). In A. gambiae refractoriness results from the mosquito's phenoloxidase defense reaction in the haemolymph being triggered by the developing oocysts (Paskewitz et al., J. Parasitol. 75:594). Refractoriness mechanisms of each type put together in the same species might form the basis of a sustainable control system.

THE *ANOPHELES GAMBIAE* COMPLEX AND MALARIA TRANSMISSION IN SOUTH AFRICA. D. le Sueur, B.L. Sharp (Research Institute for Diseases in A Tropical Environment, P.O. Box 17120, Congella, Republic of South Africa)

A brief historical perspective of malaria control in the Republic of South Africa is presented with particular emphasis being placed on the Provice of Natal and the effect on industry and tourism. Control achievements to date are highlighted as well as the reasons for the recent increase in the annual case rate (< 10,000 per annum). Amongst these are: The advent of chloroquine resistance; Agricultural development; The influx of Mozambique refugees; The exiting behaviour of *Anopheles arabiensis* from human habitations. This behavioural pattern has necessitated the re-introduction of focal larviciding as a supplementary control measure in regions where the annual application of DDT has failed to achieve total control and sporadic epidemics occur. The potential of DDT acting as a selection agent for changes in behaviour and morphology are discussed.

MOLECULAR REGULATION OF MALARIAL PARASITES IN THE MOSQUITO BLOODMEAL. R.E. Sinden*, F. Kawamota**, and I. Jones*
(* Department of Biology, Imperial College of Science, Technology and Medicine, London SW7 2BB), (** Department of Medical Zoology, School of Medicine, Nagoya University, 65 Tsuruma-Cho, Showa-Ku, Nagoya 466, Japan)

Successful transmission of malarial parasites from the vertebrate host to the mosquito vector requires that the mature male and female gametocyte ingested in the bloodmeal of the mosquito successfully undergo gametogenesis, fertilization and ookinete development in the mosquito bloodmeal prior to their potential destruction by the mosquitoes digestive enzymes. It is now clear that the induction of gametogenesis is extremely rapid, and may have both physical and macromolecular inducers. Those identified to date include a 5°C fall in temperature, and the release of small peptides by the mosquito vector. The inducers act through a complex secondary messenger pathway involving cGMP; inositol phosphates; calcium, calmodium and intracellular pH. The events triggered by these messengers include the assembly of 8, 22 um long flagella in the parasite cytoplasm, and the completion of 3 full mitotic divisions. All in less than 10 mins. The successful completion of these events, leading to the production of oocysts between the basement membrane of the midgut epithelium, and the basal lamina, may be blocked by components of the vertebrate blood system ingested into the bloodmeal together with the gametocytes. These modulators include components of the immune system e.g. antibody, white cells and non-specific factors (including cytokines), together with other factors e.g. haemoglobin content of the bloodmeal. It is hoped that a secure understanding of the molecular organisation of the regulatory mechanisms involved, may permit a rational approach to the design of a variety of malaria transmission-blocking strategies.

GENETICS, EPIDEMIOLOGY AND INTEGRATED CONTROL OF MALARIA VECTORS IN INDIA. V.P. Sharma, S.K. Subbarao and Aruna Srivastava (22, Sham Nath Marg, Delhi-54, India)

Anopheles culicifacies is the primary vector of rural and peri-urban malaria accounting for 70% cases in the country. Spraying to interrupt transmission on continuing basis have resulted in multiple resistance and control failures. Studies on polytene chromosomes have revealed that A. culicifacies is a complex of 4 sibling species with variations in their distribution pattern, response to insecticides, vectorial capacity and other behavioural characterstics. Transposition of these results to the field brought out the dynamics of malaria transmission in various regions of the country and contributed to the stratification for the implementation of the integrated vector control strategy aimed to optimize malaria control. Results of these studies would be discussed with examples from endemic states.

STUDIES ON FREE AMINO ACIDS IN HEMOLYMPH OF PARASITE-INFECTED AND UNINFECTED MOSQUITOES. Ju-sheng Wang, Ming Wei (Guiyang Medical College, Guiyang, Guizhou 550004, China)

Twenty free amino acids (FAA) were detected in hemolymph of Anopheles sinensis adult females with high performance liquid chromatograph (LC-6A). The regular changes of their amounts were as follows:

The total FAA of the mosquitoes who had an uninfected blood meal (MN) rose 37% on the 5th day after the meal and remained relatively constant, and then dropped slightly around day 12, and reincreased again thereafter on the 18th day, it got up to 2.7 times of the one at beginning.

The total FAA of the mosquitoes who had a blood meal infected with Plasmodium vivax (MIP) reduced 9.3% after the meal and kept reducing for about 12 days, and then on the 18th day, rose about 50%. The general level was much lower than that of total FAA of MN.

The total FAA of the mosquitoes who had a blood meal infected with Bruqia malayi (MIB) reduced 25% on the 5th day, and then rose 29% on the 12th day.

The changing behavior of the level of individual amino acid in cases of MIP and MIB was different significantly.

HEMOLYMPH PHENOLOXIDASE ACTIVITIES IN MOSQUITOES INFECTED WITH MICROFILARIAE. Cheng-Chen Chen (Department of Parasitology, National Yang Ming Medical College, Taipei, Taiwan, China)

Encapsulation is a commonly observed defense reaction of mosquito hosts against filarial parasites. The encapsulation of microfilariae(mf)in the haemocoel of mosquito is a biphasic process, in which rapid deposition of melanin on the surface of mf to form inner melanotic capsule is followed by the attachment of haemocytes to form outer cellular capsules. However, it is not known which enzymes participate in the formation of melanotic capsule material in the encapsulation of mf. The present study using radiometric assay and high pressure liquid chromatography with electrochemical detector was designed to investigate the activities of melanogenic enzymes, i.e. monophenol oxidase, diphenol oxidase and dopa decarboxylase, in the haemolymph of mosquito during the encapsulation process against mf. A group of 5 to 7 days old female Armigeres subalabatus were fed with rat blood infected with Brugia pahangi and another group fed with non-infected blood as control. At various time intervals post-feeding, cell free haemolymph was collected by centrifugation method. The activities of 3 enzymes in the haemolymph of mosquitoes fed with infected blood were significantly lower than those fed with uninfected blood during 3 days post-feeding and the greatest difference was seen at 24 hours. The decreased enzyme activities also coincided in time with capsule formation around mf in the haemocoel of mosquito . The results also showed that as the number of melanized mf and their sheathes in the haemocoel increased, there were significant declines in the activities of monophenol oxidase, diphenol oxidase and dopa decarboxylase. The consumption of monophenol oxidase, diphenol oxidase and dopa decarboxylase during the melanization of mf and their sheaths in the haemocoel of filaria-infected mosquitoes is discussed.

GENETICS OF VECTOR COMPETENCE OF AEDES ALBOPICTUS TO DENGUE. K.S. Rai, R.D. Boromisa, R.E. Thomas and C.F. Bosio (Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556, U.S.A.)

Aedes albopictus, a mosquito species native to Asia, is an important vector of dengue and dengue hemorrhagic fevers. Following its introduction to the continental United States in 1985, it is currently well established in 21 southern, midwestern and eastern states. It poses a serious public health threat because of its potential to become involved in the transmission of dengue and other indigenous viruses in the Western Hemisphere.

Eight geographic strains of Ae. albopictus from North America and Asia and one North American strain of Ae. aegypti were tested for their vector competence with dengue-1 virus (Fiji). All strains tested, except the HOUSTON (U.S.) strain, showed high susceptibility to midgut infection. However, there were marked differences in percent disseminated infection and transmission rates among the various strains tested, more or less paralleling allozyme differentiation among these strains. In general strains from dengue endemic/epidemic regions of Asia showed significantly higher susceptibility to disseminated infection and oral transmission than those of the U.S. and Japan (non-endemic). These rates were generally stable over several generations.

Considerable variation among strains was also observed in both their vertical transmission rates (percentage of infected females that transmit dengue virus to one or more offspring) and the filial infection rates (percentage of progeny of infected females that are vertically infected). The vertically infected offspring tended to be clumped within families suggesting a strong genetic component to vertical transmission. The inheritance of midgut infection and disseminated infection profiles was examined by making crosses and backcrosses between strains showing marked differences in these traits. The preliminary data suggest likely polygenic control of these traits and strong influence of maternal phenotype in determining susceptibility of progeny particularly for disseminated infection.

DNA-MEDIATED GENE TRANSFER: PROSPECTS FOR GENETIC CONTROL OF MOSQUITOES. Ann M. Fallon (Department of Entomology,University of Minnesota, St. Paul, MN 55108 USA)

The potential applications of DNA-mediated gene transfer to genetic control of insect-vectored disease have stimulated molecular research on the genetics and biochemistry of mosquito cell lines. Exogenous DNA can be reliably introduced into cultured mosquito cells using chemical agents such as polybrene or calcium phosphate, with frequencies as high as 1/1000. This efficiency is sufficient for analysis of genes expressed from strong promoters, such as that from the Drosophila heat shock protein hsp70 gene. To facilitate selective recovery of transfected cells, we have cloned the mosquito dihydrofolate reductase gene, which confers resistance to the folate analog methotrexate. Chimeric plasmid DNA containing this gene is stably maintained in transfected cells for at least 3 months. Our long term goal is to develop and test, using cultured cells, DNA constructs that could interfere with disease transmission by disrupting the reproductive cycle. Current efforts focus on ribosomal RNA and ribosomal protein genes, which are abundantly expressed during vitellogenesis. By DNA sequence analysis, we have shown that the rDNA intergenic spacer contains multiple regulatory elements whose functions can be defined in transfected cells. Similarly, cloned DNA encoding ribosomal proteins rpL8 and rpL31 will be used to test whether antisense expression of these genes can be used to disrupt ribosome biosynthesis in transfected cells. If successful, these constructs may be useful in constructing transgenic mosquitoes.

THE BREEDING HABITS OF HOUSE FLY AND OTHER SYNANTHROPIC FLIES IN CHINA. Meng-yu Zhang, Ze-min Li, Bing-xing Wei, Nian-gong Guo (Department of Parasitology, Hebei Medical College, Shijiazhuang 050017,China)

A general survey of breeding places of common flies was made in twenty cities and twons of China in 1980s. In this work, 86 species of flies are discovered, of which 4 species are most dominant. They are *Musca domestica*,*Lucilia sericata*, *Boettcherisca peregrina* and *Muscina stabulans*. Breeding places of flies are classified into 5 types: (1) human feces, (2) animal excrement, (3)decomposing animal matter, (4) decaying vegetable matter and (5) garbage. The breeding places of *M. domestica* are very extensive. The breeding matters of higher frequency of its occurrence are distillers'grains,vinegar residue(after making vinegar), hair and fur, horse dung and manure, pig dung and manure, fowl excrement, manure pit, fodder, cow dung and manure, latrine and so on. In decomposing animal matter, such as small carcases and the waste material from the butchery, *L. sericata* is the most common species and *B.peregrina* mainly breeds in human feces and *M.stabulans* in decaying vegetable matter. Control measures of the flies are proposed based upon the result of this general survey.

STRATEGIES FOR INTEGRATED CONTROL OF HOUSEFLIES ON DANISH FARMS. Jørgen B. Jespersen (The Danish Pest Infestation Laboratory, Skovbrynet 14, DK-2800 Lyngby, Denmark).

The use of insecticides against the housefly *Musca domestica* has been the major fly control method since the 1940's. However, there is an increasing need for strategies for integrated control of houseflies mainly due to: (1) concern for the environment, and (2) insecticide resistance problems resulting in fly control failure. For this reason the cost effectiveness of sticky fly paper traps against the housefly has been evaluated in field trials. The results, including the adverse effects, will be presented and discussed. Besides, assessment of the resistance risk of two IDI's (diflubenzuron and cyromazine) used for control of houseflies in Denmark will be discussed. In the light of these results, strategies to delay or reverse the development of resistance to insecticides will be presented.

A STUDY ON THE INTEGRETED CONTROL OF FLIES IN CHIFENG CITY. Wan-bin Jiao (Council of chifeng patriotic health movement. Chifeng 024000. China) Shuyuan-Zhang (Institute of Epidemiology and Microbiology. Chinese Academy of preventive Medicine. Bejing 102206. China)

Succesesful applying Deltamethrin at the concentration of 20mg m², and Cypermethrin of 40mg m² were used in door. Thus it was sufficientary to control breeding of flies. The Health in spections were conducted by specialits from Council of ontrol Patriotic health movements, the results showed that they checked defferent kinds of rooms 1213 the density rate of the flies were 1.65% (20 rooms were found flies) and checked different kind of breeding sites 348 places, the positive sites only in three, the breeding rate of flies were 0.86%. Besides the esperiances has been achieved, the measurement and managements were carried out in the Chifeng, is very useful and economic and suitable for the local. This also could apply in the other middle size town in futrue.

KILLING EFFECT OF FERMENTATION OF SOLID WASTE ON FLIES. Jingxiong Li (The Urban Environmental Sanitation Association of Zhejiang Province) Chunxuan Chai (The Epidemic Prevention Station of Zhejiang Province) Yuaner Hao (The Scientific Research Institute for Environmental Sanitation of Hangzhou China)

The experiment was conducted from the July to the November of 1991, by means of static fermentation and dynamic fermentation respectivety. The average temperature of the composing material in static state is 46. 06℃ and the upmost temperature reaches 76.5℃ but 62.88℃ dynamic state, and the upmost 87℃ Maggot-burying. Living maggots of the 3rd stage of domestic musca feeded in the lab were put into 18 emptied and perforated drinking-cans and 18 plasticbags respectively with 300 maggots in each can and 400 in each bag. All the 12600 maggots were evenly buried in the chamber from bottom to top. In addition, another 3000 living maggots of the 3rd stage were freely distributed in the chamber. All the maggots in the cans and bags were killed when the fermented materials, both in static and dynamic state, were discharged from the chamber. By sampling, there were 73 maggots per kilogram in the 8 tons of fresh waste, before waste was filled into the chamber, but no living maggot was discovered in the waste in the course of discharging.

The Fly Problems and Control of Synanthropic Flies in the Poultry Houses in Japan

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Synanthropic flies, such as the housefly,the lesser housefly and nonbiting stablefly pose significant pest problems in animal houses in Japan. Animal houses,particularly the deep bed poultry houses introduced into Japan in the past 2 decades from some Europian countries and the USA have become overwhelming breeding sources of these flies because of Japan's geographical location. The common houseflies are controlled generally by using insect growth regulators in Japan but the larvae of *Fannia* flies in the manure on the boards in the deep bed houses either tolerate or escape contact with IGRs and OP larvicides. Male *Fannia* invade neighborhood areas after emergence,while females generally stay in the poulty houses. Succesful control of *Fannia* was achieved by using the paint on baits on the ceiling of the houses where they rest.The famers are requested to withdraw the boards from the barns in oder to lead the houseflies larvae in the beds.Then they would be controled with the IGRs. Resistance to IGRs is not a serious problems in the animal houses in Japan. Pyrethroids for adult control and attractants of adults are being investigated.

CONTROL OF THE HOUSE FLY IN THE DUMPING SITE OF TOKYO. Kono, Y., Tomita, T., Takahashi, E. and Mihara, M. (Dept. of Medical Entomology, National Institute of Health, Tokyo, Japan)

Huge amount of wastes(10000t/day) in the metropolis of Tokyo are disposed at landfill site(ca. 400ha) in the Bay of Tokyo. Certain part of the wastes caused the occurence of nuisance insects such as the house fly and sometimes the outbreak of the house fly which invaded the neighbouring residential places.

We report the history of house fly control and recent problem of insecticide resistance in the landfill site regarding following items.

1) Life cycle of the house fly and the control
2) Practical evaluation of the control agents
3) Changes of insecticide susceptibility and the control agents
4) Pyrethroid resistance and the monitoring
5) Recent problem and the solution

STUDY ON INTEGRATED CONTROL FOR MAJAR SYNANTHROPIC FLIES AND ITS CONSOLIDATATION AND EXTENSION IN GUANGDONG. Ziru An, Shen Xiao (Health and Epidemic Prevention Station of Guangdong Province, Guangzhou 510300, China)

This paper reported an fly integrated control study mainly using environmental measures to eliminate and control breeding sources of synanthropic flies in Taishen, Foshan and Shenzhen, in Guangdong Province. The five measures were taken in account, which were improvement of environmental condition such as toilet, fool market and slaughterhouse constructed or reconstructed with flyproof provision, bargage, organic waste and excrement harmless treated, completement of basic organization and specialized team which controled vector and medical insects, health education, legal management and insecticide treatment if it is neccesary. After 2 years controled, the breeding rate was decreased from 16.68% to 2.23%, an average number of 8. 39 adult flies were found in 4.5 room out of 100 rooms in Taishen in 1987. These measures were continuelly taken to keep fly at a low level in Taishen and then extended to other city. In 1991, the breeding rate was kept at a low level of 0.23%, a number of 247 adult flies were found in 194 rooms out of 9322 rooms in Taishen, 0.18% of breeding rate, 3 adult flies in 3 rooms out of 832 rooms in Foshan in 1990, 0.5% of breeding rate, 10 adult flies in 10 rooms out of 6225 rooms in Shenzhen in 1991. All of these were authenticated by the fly control section of national specialist committee for vector biology and control.

CYROMAZINE TOLERANCE IN FIELD POPULATIONS OF HOUSEFLIES IN ISRAEL. H. Pener (Laboratory of Entomology, Ministry of Health Jerusalem 91060, Israel.

Cyromazine has been integrated in housefly control employing two formulations; Neporex, as residual spraying of manure and Larvadex as a feed through for poultry.

After four years of use, four populations of houseflies were tested for tolerance/resistance. The results showed a clear correlation between the history of treatment and the resistance/tolerance situation in each of the populations tested. The highest resistance factor (R/S) was noted for the population which had been consistently controlled with Neporex (residual spray), the lowest R/S was noted for the population controlled only with Larvadex, while two populations for which cyromazine had been only sporadically employed (complementary to conventional control) showed only different degrees of tolerance.

The future use of cyromazine in housefly management program in Israel will be considered according to these results.

SUPPRESSION OF HOUSE FLY AND STABLE FLY POPULATIONS BY TWO SPECIES OF PUPAL PARASITES. Shan-qing Wang, Ai-xiang Xiao, Jie Zhang, Ren-bin Chen, Wen-zhong Zhang(Department of Parasitology, Shanxi Medical College, Taiyuan 030001, China)

The two pteromalid wasps, Spalangia endius Walker and Nasonia vitripennis (Walker), were released for 14 weeks on field fly breeding habitats for the control of Musca domestica Linn. and Muscina stabulans (Fallen). As compared with nonrelease lots, the densities of house flies and stable flies on the release lot of N. vitripennis were reduced to 40 per cent and 68 per cent, respectively, and on the release lot of S. endius, the densities of the two flies were reduced to 44 per cent and 60 per cent, respectively. The two pupal parasites in this study were effective in controlling house fly and stable fly populations under the conditions imposed and at the numbers released.

REDUCTION OF STABLE FLIES WITH ADAPTED PARASITES AND FLY BREEDING SITE REDUCTION. GERALD L. GREENE, KSU, SWKS Res-Ext. Center, Garden City, KS 648746.

Samples of stable fly (Stomoxys calcitrans) pupae for ten years from cattle feedlots have shown what parasite species are abundant. Four Pteromalidae species form two genera were common, Muscidifurax zaraptor, M. raptor, Spalangia nigroaenea and S. cameroni. Spalangia nigroaenea was the most common parasite from stable fly puparia. It was not produced commercially, even though the other species were.

Commercial production of S. nigroaenea was developed and mass released during early spring, when stable flies are numerous, has shown stable fly reductions. Releases of 50 parasites per week per animal have increased pupal parasitism and reduced fly numbers compared to cattle feedlots where parasites were not released.

Parasite releases in combination with cleaning and removal of the fly breeding sites has proven to be economical for cattle feedlots in Kansas. Proper management is the key to stable fly reduction below the economical damage level.

FLEAS AS PLAGUE VECTORS IN NATURAL FOCI AND THEIR DISTRIBUTIONS IN CHINA. Houyong Wu and Jintong Zhang (Institute of Microbiology and Epidemiology, Beijing 100071, China)

China is one of the countries in the world which have the most plentiful species of fleas. A total of more than 530 species of fleas has been found in China up to date. Among them, however, only a few, less than fifty species, is of epidemiological importance from which the plague pathogen, *Yersinia pest*, had been successfully isolated. The 10 most important vector fleas in China, which distributed in 8 different types of plague foci, are: *Citellophilus tesquorum, Oropsylla silantiewi, Callopsylla dolabris, Nosopsyllus laeviceps, Neopsylla pleskei, Xenopsylla conformis, Amphipsylla primaris, Ctenophthalmus quadratus, Frontopsylla luculenta* and *Rhadinopsylla li*. The sketch maps for their distributions are presented in this paper.

No Fleas or Lice to Call Their Own. ROBERT TRAUB, (DEPARTMENT OF ENTOMOLOGY, MSC, SMITHSONIAN INST., WASHINGTON, D.C. 20560, USA) LANCE DURDEN, (DEPARTMENT OF ARBOVIRAL ENTOMOLOGY, VIROLOGY DIVISION, USAMRIID, FORT DETRICK, FREDERICK, MD 21702, USA)

Although most groups of mammals are parasitized by characteristic fleas (Siphonaptera) and sucking lice (Anoplura), certain mammal taxa are devoid of such ectoparasites. Whales, sea cows, and elephants all lack specific fleas and sucking lice. Additional mammals that are not parasitized by characteristic fleas are flying lemurs (Dermoptera), primates (sensu stricto), and aardvarks; while those that lack specific sucking lice are the monotremes, marsupials, bats, edentates and pangolins. In addition, many aquatic mammals have secondarily lost their associated fleas and/or sucking lice.

These and additional patterns of host-flea/louse association provide clues towards the place and time of origin of these two groups of ectoparasites.

ECOLOGICAL STUDIES OF SIPHONAPTERA ASSOCIATED WITH SMALL MAMMALS NEAR LAKE OMHA ON ENGLISH PEAKS, OWEN STANLEY MTN RANGE IN PAPUA NEW GUINEA, Emmett R. Easton, (Macau Polytechnic Institute(formerly University of Macau, P.O. Box 3001, Macau)

Ecological studies were undertaken in a sub-alpine habitat on Mt.Scratchly in 1988. Dacrycarpus compactus is the dominant tree on forested slopes forming a canopy of 15-20 m while shrubs near the ground are moss covered. Extensive valley bogs are found below the level of Lake Omha which are dominated by Carpha alpina and grassland areas are bleached with trunks of fallen trees(elevation 3,650m).

Small mammals examined include Rattus niobe(moss forest rat and Peroryctes longicauda(bandicoot) that were live trapped using Elliot collapsible aluminum box traps, the fleas removed under light etherization in plastic bags and hosts released for recapture. One male bandicoot was parasitized with a total of 117 fleas composed of 3 different taxa while 43 specimens of siphonaptera were recovered from moss forest rats. One of the taxa recovered from the bandicoots is currently new to science in the genus Striopsylla Traub and Easton, in prep.)while the second most abundant species was identified as Pygiopsylla spinata Holland and the 3rd as Papuapsylla corrugis(Jordan).

STUDIES ON OVERWINTERING OF THE FLEA *CITELLOPHILUS TESQUORUM SUNGARIS* (SIPHONAPTERA: CERATOPHYLLIDAE). Cheng-yi Li, Hou-yong Wu (Intstitute of Microbiology and Epidemiology, Beijing 100071, China)

Studies on overwintering of the flea *Citellophilus tesquorum sungaris* were carried out under vitro and in vitro conditions from Aug. 1989 to Mar. 1991. The results showed that adults are the most important stage for the flea to overwinter. It is necessary for the adult fleas to have several times of blood-meal during their overwintering period, otherwise they will die before the process finished. Host animals of the flea, *Citellus dauricus dauricus*, awaken intermittenly and their body temperature may rise again as high as to 32℃ during the period of winter hibernation. These phenomena make it possible for adult fleas to feed on and cause their gonad to develop further, at last most of the femal individuals have been in the stage of egg-laying, and some of them even have laid their eggs for several times before their host fully awakened. No diapaus occured in the process of overwintering for the fleas. Other problems such as the levels of glycerol, glycogen, glucose, trehalose and the total lipids and carbohydrates in the overwintering femal adults were also investigated and compared with that of the normal ones.

METAMORPHOSIS OF FLEAS. Rui-yu Ye, Xin-ru Chen, Xin Yu (Institute for Endemic Disease Control and Research, Urumqi, Xinjiang 830002, China), Jin-tong Zhang (Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, China)

The dynamics of developmental processes of fleas were studied by cultivation of flea eggs, third instar larvae and bare pupae, and by means of microscopy and of the technique of microvideotaping.

A series of forward telescopic contractions from the posteriors of the body culminated the internal tension of the old case, providing the main motive forces for metamorphosis. The process of moult of the well developed larva started from the longitudinal ripping of the egg shell by the hatch spine, advanced in thorax-head-abdomen sequence, and completed within 2 or more minutes. The first step of pupation was the wriggle of pupal thorax out of the slit on the dorsal tergite of larval thorax, followed by the dissociation of pupal head, and then of the legs and abdomen of the pupa. The whole process took 10-20 minutes. The process of emergence took in head-thorax-abdomen sequence and, averagely, took 5-20 minutes.

The observations, including 41 eggs of 5 species, 56 larvae of 10 species and 25 pupae of 6 species, showed that the processes of metamorphosis in all the observed species presented an uniform profile. Some biological and ecological aspects of concerned phenomena are discussed.

SEASONAL DYNAMICS OF *Parapsyllus longicornis* (SIPHONAPTERA: RHOPALOPSYLLIDAE) ASSOCIATED WITH THE WHITE-FLIPPERED PENGUIN ON BANKS PENINSULA, NEW ZEALAND. T.D. Galloway (Dept. of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2) and C.N. Challies (22A Highfield Pl., Christchurch, New Zealand).

White-flippered Penguins (*Eudyptula minor albosignata*) breed in burrows and caves from September to January, and moult during January and February. Two to three months before egg-laying, only small numbers of adult fleas were present in the nest debris. As adult birds spent progressively more time at their nests, numbers of larvae increased through the period of egg-laying, reaching a peak when chicks were present. A new cohort of adult fleas appeared as the chicks matured, inferred from the increasing numbers of adult fleas in the nest debris and by the presence of female fleas at early stages of ovarian development. Adult fleas, but no larvae, were found in nests not known to have been occupied during the current breeding season. Female fleas at one location, where the penguin colony was small and the nest burrows widely separated, had a greater mean number of ovarioles than females at the other, where the colony was larger, and where in one area, the penguins' nests were open on the floor of a small cave.

A NEW FAMILY OF FLEA, LIUOPSYLLIDAE FAM. NOV. (INSECTA: SIPHONAPTERA). Dun-qing Wang (Laboratory of Medical Entomology, Fujian Medical College, Fuzhou 350004, China), Jing-yuan Liu (Institute of Parasitic Diseases, Hubei Academy of Medical Sciences, Wuhan, 430070, China)

This paper reports a new family of flea Liuopsyllidae fam. nov. raised from the subfamily Liuopsyllinae Zhang, Wu et Liu, 1985. After studying the characters of Liuopsylla conica Zhang, Wu et Liu, 1985 and Liuopsylla clavula Xie et Duan, 1990, the authors deemed that the subfamily Liuopsyllinae is unsuitable to placed under either family Hystrichopsyllidae or family Leptopsyllidae, because the features of Liuopsyllinae broked the boundary line of these two families. If we raised the subfamily Liuopsyllinae into family rank, then the boundary lines of these three families will be clearly again. A table to differentiated Liuopsyllidae fam. nov. from the closely related families Hystrichopsyllidae, Leptopsyllidae and Ischnopsyllidae is given. The fauna and distribution of Liuopsyllidae fam. nov. is also calculated.

A STUDY ON THE PHALLOSOME OF FIVE MALE FLEAS: OBSERVES ON THE LATERAL, DORSAL AND VENTRAL SIDES. Xiao-jun Pan (Department of Biology, Guangzhou Normal College, Guangzhou 510400, China).

The lateral, dorsal and ventral sides of phallosome of five male flea species were observed under both optic microscope and scanning electron microscope, i. e. Neopsylla specialis specialis Jordan, 1932, Neopsylla dispar fukienensis Chao, 1947, Ctenophthalmus eothenomus Li et Huang, 1980, Leptopsylla segnis (Schönherr, 1811), Nosopsyllus wualis bo-seensis Li & Pan, 1990. The morphology of phallosomes of these species were described and compared. Their main identification characters had been pointed out. It is helpful to observe the dorsal and ventral sides of phallosomes in order to understand the organs better.

COMPARISONS BETWEEN FOUR SUBSPECIES OF CITELLOPHILUS TESQUORUM ON THEIR PHYSIOLOGICAL AND BIOCHEMICAL CHARACTERS AND ULTRASTRUCTURES. Shan-qing Wang(Dept. of Parasitology, Shanxi Medical College, Taiyuan 030001, China), Zhi-ying Liu, Hou-yong Wu(Inst. of Microbiology & Epidemiology, Beijing 100071, China)

The subject concerning the distribution and the subspecies taxonomy of Citellophilus tesquorum remains in controversy up tp date. The contention was focused on how many subspecies there actully exist in China. An effort has been contributed to the advanced study for the problem by employing the components and contents in percentage of amino acids, fatty acids, monosaccharides and cuticular hydrocarbons, and by the ultrastructural observations and the ratios of N, C elements. The results of the studies showed that C. t. sungaris, C. t.mongolicus, C. t. altaicus and C. t. dzetysuensis should be established since the existances of some relatively stable characters in, and of the great singnificant differences between the four subspecies. Nevertheless, it could also be made out that some generalities were existed in the four subspecies. So it is supposed that the four members are sitll on the subspecies level in the systematical views.

A REVISION AND SUPPLEMENT OF THE GENERIC CHARACTERS OF THE GENUS PARADOXOPSYLLUS(SIPHONAPTERA: LEPTOPSYLLIDAE) WITH A DISCUSSION ON THE RELATIONSHIP BETWEEN THE GENUS AND ITS CLOSER RELATIVES. Quan Liu, Hou-yong Wu (Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, China)

Paradoxopsyllus and Ophthalmopsylla, are the two genera of closer relatives in systematics. With a steady increase in new members some taxonnomic confusions have resulted recently for the insufficiency of unequivocal diagnostic characters. Based on the studies of the specimens collected from China, the authors make a revision for and give a supplement to,the characters of these genera. Two diagnostic characters are newly recommended here: the dorso-lateral lobes of the aedeagus are presented in Paradoxopsyllus but not in Ophthalmopsylla, and a developed spiniform process with a Y-shaped apex is visible on the inner tube of the penis in Paradoxopsyllus but not in Ophthalmopsylla. A table is to list the main differences between the two genera, and then follows a brief discussion on the relationship between the two genera on comparative morphology and the host-relationship.

A MORPHOMETRIC COMPARISON OF TWO POPULATIONS OF PLAGUE VECTOR, XENOPSYLLA CHEOPIS - - FROM AN ENDEMIC AREA AND A PURE LINE LABORATORY STRAIN, S.S. Seghal, M.K. Nayak (Department of Zoology, University of Delhi, Delhi - 110 007, INDIA).

Live rats from plague endemic domestic and peri domestic localities in Southern India were trapped. The fleas were collected and subjected to morphometric — analysis. Similar study was also conducted on the specimens maintained as a pure line culture in the laboratory. Five morphometric traits of head and thorax of both the strains were compared. Co-efficient of variation was used to analyse the size frequency distribution of different traits. The second tarsus of the fore-leg and the fourth tarsi of mid-and hind-legs exhibited highest variability (CV<10.0) in both the strains while the antennae showed least variability. The femora of the hind-legs in two strains exhibited differential co-efficient of variation. The analysis attempts to address the subject of size variation of different traits and to discuss its possible manifestation of genotype-environmental interaction.

TAXONOMY OF FLEA LARVAE. II: DIFFERENTIATION AMONG LOWER TAXA. Robert L.C.Pilgrim(Department of Zoology, University of Canterbury, Christchurch, New Zealand). There are numerous external morphological features that are valuable in diagnosing many flea larvae at the generic and lower levels. Three examples will be discussed in detail.

i) At the subgeneric level, separation of the (European) Palaearctic *Hystrichopsylla s.s.* (Hystrichopsyllidae) (3 taxa) from the Nearctic *Hystroceras* (3 taxa) can be effected on the basis of mandible form and abdominal setation.

ii) At the species level, separation of the 4 species of *Notiopsylla* (Pygiopsyllidae) can be made on an analysis of the 'barbula' on the venter of thoracic segments, with some complementary evidence from the arrangement of antennal mound structures.

iii) At the subspecies level, several taxa of the *Ceratophyllus styx* complex (Ceratophyllidae) occurring in nests of Hirundinidae can be separated by differences in setation of the ventral plates on the thoracic segments. Thus, reconsideration of the species *vs* subspecies status of *Ceratophyllus styx riparius* J.& R., and of *C. s. freyi* Nordberg is warranted. These 2 taxa are, on the evidence of larval morphology, closer to each other than they are to *C. styx styx* Rothschild and *C. s. jordani* Smit. Larvae of this latter pair of taxa cannot yet be separated from each other.

TAXONOMY OF FLEA LARVAE. I: HIGHER TAXONOMY.
Robert L.C.Pilgrim (Department of Zoology, University of Canterbury, Christchurch, New Zealand).

Higher taxa (superfamilies, families, sub-families) among known flea larvae can be separated by reference to a range of external morphological features. Number and distribution of setae on the head capsule distinguish Pulicoidea (Pulicidae + Tungidae) from the remainder of the order Siphonaptera. Within Pulicidae, subfamilies are separable largely on the number of setae and their positions relative to sensilla in the posterior row on the abdominal dorsal plates. The larvae of non-Pulicoid families cannot, at present, be classified according to the 4 currently recognised superfamilies that are based on adult features. However, combinations of certain characters (especially types of setae, numbers and patterns of setae and sensilla on head, thorax and abdomen, and integumentary ornamentation) are particularly valuable taxonomically. Using these characters, flea larvae can be separated into families and, in many cases, subfamilies.

TAXONOMIC REVIEW OF GENERA AND SUBGENERA OF RHOPALOPSYLLINAE (SIPHONAPTERA) BY PHENETIC AND CLADISTIC METHODS. Pedro Marcos Linardi (Deptº Parasitologia ICB/Universidade Federal de Minas Gerais, C. P. 2486, 31.270, Belo Horizonte, Minas Gerais, Brasil. Research fellow of CNPq).

A taxonomic review of genera and subgenera of Siphonaptera Rhopalopsyllinae comprising nine OTU's is presented based on phenetic and cladistic analysis. Twenty-eight characters of adults were analysed and the character states determined for each character by out-group method.

Phenogram and cladograms indicated two tribes, each with two subtribes. Taxonomic changes proposed as a result of this study include the raising of the subgeneric status of Gephyropsylla, Hechtiella, and Ayeshaepsylla to independent genera; the recognition of a new genus, Neotropsylla, to include Polygenis guimaraesi Linardi; the division of the genus Polygenis Jordan into two subgenera: Neopolygenis subgen. n., to include species of the atopus group, and Polygenis s. str., for remainding species.

HOST IMMUNITY AND VECTOR PHYSIOLOGY. Manthri S. Ramasamy, K. Alagaratnam Srikrishnaraj and Ranjan Ramasamy (Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka).

Antibodies were produced in rabbits against tissues derived from laboratory colonies of the malaria vector *Anopheles tessellatus*. The presence of these antibodies in a blood meal reduced fecundity of *An. tessellatus* but not of *Culex quiquefasciatus*. Because many antigens are shared between *An. tessellatus* and *Cx. quinquefasciatus*, this indicates that species-specific antigens are the relevant targets. The reduction in fecundity was variable and was observed with antibodies to midgut tissues and abdomen tissues without midgut. These observations are consistent with our previous reports that anti-mosquito antibodies reduce the fecundity of *Aedes aegypti* mosquitoes.

HOST REGULATION OF ARTHROPOD-BORNE PROTOZOAN AND BACTERIAL PARASITES: THE ROLE OF TRANSMISSION BLOCKING ANTIBODIES. R. A. Wirtz (Walter Reed Army Institute of Research, Washington, D.C., USA), A. F. Azad (University of Maryland School of Medicine, Baltimore, MD, USA).

Blood-feeding arthropods imbibe host immunoglobulins during the blood meal. In some arthropods significant amounts of these large molecular weight immunoglobulins (e.g., IgG) remain intact and retain their ability to bind with specific vector or parasite antigens after passing from the gut into the hemocoel. These antibodies may change vector survival or fecundity and parasite development or infectivity. The regulatory role of specific transmission blocking antibodies against protozoan and bacterial parasites taken with the blood meal by vector arthropods will be discussed.

ROLE OF HOST IMMUNITY IN THE TRANSMISSION OF VECTOR BORNE DISEASES. Ranjan Ramasamy, K. Alagaratnam Srikrishnaraj and Manthri S. Ramasamy (Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka)

Cellular and humoral immune responses against arthropod vector antigens in vertebrate hosts affect vector physiology and significantly modulate the transmission of pathogens. This phenomenon may be the basis for novel methods of disease control based on immunisation against arthropod antigens. We have previously reported that anti-mosquito antibodies ingested in a blood meal reduce the infectivity of the murine malaria parasite ***Plasmodium berghei*** and medically important arboviruses to mosquitoes. Here we report that rabbit antibodies raised against *Anopheles tessellatus* mosquitoes reduce the infectivity of the human malaria parasite *P. vivax*. We postulate that the antibodies interfere with the movement of ookinetes by blocking receptors in the midgut epithelium.

DIGESTION AND JUVENILE HORMONE BIOSYNTHESIS IN SAND FLIES. Dov Borovsky (University of Florida-IFAS, FMEL, 200 9th Street S.E., Vero Beach, FL 32962, USA), Fardia Mahmood (Yale Arbovirus Research Unit, Dept. of Epidemiology and Public Health, Yale University School of Medicine, New Haven, CT 06510 USA), Y. Schlein (Dept. of Parasaitology, The Hebrew University, Hadassah Medical School, Jerusalem ISRAEL)

The biosynthesis of trypsin-like and chymotrypsin-like enzymes was followed in the larvae and adults of the sand fly *Lutzomyia anthophora*. Chymotrypsin-like enzymes were more active during the larval stages, whereas trypsinlike enzymes were more active in adults after the blood meal. In *Phelebotomus papatasi* both enzymes were modulated after the blood meal by its parasite *Leishmania major* and enhanced the survival of the parasite in the sand fly's midgut. The biosynthesis of juvenile hormone III (JH III) by the corpora allata (CA) of *L. anthophora* was also followed before and after the blood meal. JH III biosynthesis increased following the blood meal for the first 4 h and then declined reaching a minimum at 30 hr. A comparison between egg development and JH III biosynthesis will be discussed.

DIVERSITY OF TSETSE TRANSMITTED TRYPANOSOMA BRUCEI WITHIN A SMALL LOCALITY IN KENYA

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In the Lambwe Valley, Kenya, there is very close association between Glossina pallidipes, cattle and humans. Since transmission cycles for all Trypanosoma brucei must necessarily be linked through the tsetse vector, it was expected that some of the T. brucei found in the tsetse to reflect those circulating in the human population living around the valley. Using isoenzyme Glucosephospho isomerase and Phosphoglucomutase as genetic markers for T. brucei, the relationship between the isolates from cattle, tsetse and humans were examined. The results showed that there was a wide diversity in the number of zymodemes expressed by T. brucei from tsetse, and comparatively fewer zymodemes were detected in cattle and human isolates. Very few common zymodemes between man and tsetse were found. The specificity of isoenzyme variation to the source of the isolate and the high level of diversity of non-human isolates was indeed puzzling.

THE SIGNIFICANCE OF MODALITY, NUMBER, AND LOCATION OF SENSILLA THAT MEDIATE STIMULI USED BY HAEMATOPHAGOUS INSECTS IN HOST LOCATION AND DISCRIMINATION. Susan B. McIver, (C 95 Reynolds Road, RR 1, Fulford Harbour, British Columbia, Canada VOS 1CO)

FACTORS AFFECTING INTERACTIONS BETWEEN MOSQUITOES AND THEIR HOSTS: THE ROLE OF ODOURS IN HOST-SEEKING AND ORIENTATION. W. Takken (Department of Entomology, Agricultural University, PO Box 8031, 6700 EH Wageningen, The Netherlands)

Mosquitoes make use of odours emitted by their mammalian hosts in host-seeking and orientation. In this process, the insects show selected preferences for specific hosts, which are thought to be caused by the host-specific odour composition. Little is known about the chemical composition of the odours and the host-seeking mechanism used to reach the host. Carbon dioxide plays a crucial role in host-seeking, but other volatiles determine orientation, steering and landing mechanisms. Recent findings about the role of several host-derived chemical stimuli will be discussed.

INTRA-SPECIFIC VARIABILITY IN ODOUR AND HOST SELECTION IN HAEMATOPHAGOUS INSECTS. **Gethin Thomas, Joris J. Trapman** (Laboratory of Behaviour Physiology, Central Veterinary Institute, P.O. Box 65, 8200 AB LELYSTAD, The Netherlands)

Relative differences between hosts in their attractiveness for hematophagous insects will lead to differences in pestation loads and thus have consequences on the risk of contacting vector transmitted disease. Evidence supporting this hypothesis is presented using summer mastitis (a bacterial infection of the udder in cattle) and *Hydrotaea irritans*, its fly vector as a model. Analysis of relative differences in attractiveness between hosts showed that odour (kairomone) played a primary role. Odour differences remain stable not only within a season but also between seasons and good correlations were found between mother and offspring. Results will be presented aimed at identifying these kairomones using electrophysiological and bioassay techniques.

MECHANISMS OF HOST-ECTOPARASITE CONTACT. Donald R. Barnard (Medical and Veterinary Entomology Research Laboratory, USDA, ARS, P.O. Box 14565, Gainesville, FL 32604, USA)

At least five groups of parameters regulate contact between ticks (Acari: Ixodidae) and host animals. Group one (seasonal effects) and group two (daily effects) comprise abiotic parameters and include day-length, temperature, relative humidity, and interactions thereof. Groups three, four, and five consist of biotic parameters. These pertain to biological processes in ticks (group three), such as hunger responses and spatial patterns in aphagous tick populations; biological processes in host animals (group four), such as patterns of habitat utilization by host animals; and interactions between host animals and ticks (group five). Host-tick contact is possible when ticks are hungry, when ticks exhibit a positive appetence response, and when ticks and host animals are together in time and space. A descriptive model is proposed to correlate these processes and interactions with the observed behavior of the host-tick contact system in nature. Emphasis in the model is placed on host activity and differences among host types.

RECENT ADVANCES IN THE USE OF SEMIOCHEMICALS IN THE DEVELOPMENT OF INNOCATIVE PEST MANAGEMENT STRATEGIES FOR BLOODFEEDING INSECTS

D.L. Kline and C.E. Schreck (Medical and Veterinary Entomology Research Laboratory USDA, ARS, P.O. Box 14565, Gainesville, FL 32604, USA)

Different species of haematophagous insects utilize different combinations of host-produced physico-chemical cues to initiate and complete the host-location process. Recent tsetse research has shown the importance of kairomones obtained from the breath and urine of the hosts for use in surveillance and control programs. The importance of visual cues was also demonstrated. These same chemical and physico-cues have been found to be very effective in the host-finding mechanisms of other biting flies including mosquitoes, biting midges, tabanids and oestrids. Laboratory tests show isolated emanations from several species of anthropophylic mosquitoes. With the exception of lactic acid and carbon dioxide human host-borne chemicals which attract blood feeding insects are not known. Chemical analysis of bioassay procedures distinguish key attractive elements for use in pest management strategies.

CURRENT ADVANCE OF BLOOD-SUCKING FLY STUDY IN JAPAN EXCEPT MOSQUITOES. Hirosi Takahasi (40-11, Hayamiya-1, Nerima, Tokyo, Japan)

Until 1940, 31 species of Tabanidae were recorded from Japan and the description of immature stages was limited to only one speceis. But now, Japanese Tabanid fly was classified into 105 speceis and the biology of 70 species has been studied. In consequence, it was found that many severe blood-suckers took blood-meal after their first oviposition. That is, the control of adult flies have no effect on the emergence of the flies next year. As an effective control measure, an automatic controlled fly trap with CO_2 gas was designed by Dr.Hayakawa.

In 1935, Prof.Shiraki described 16 species of black-fly from Japan without any description of immature stages. Now we found 62 species of Simuliidae with their immature stages. It is noticeable that only 4 species of the flies are common with outside of the islands but it may be revised by the future detailed study in the neighbouring area. As the control measure, we had engaged in a black-fly control plan as a part of onchocerciasis eradication project in Central America in cooperation with Guatemalan scientists. After 8 years, nobody was attacked by the flies in the pilot area which included 8 villages, 300 km^2.

MAKING LIFE DIFFICULT FOR *CULICOIDES VARIIPENNIS*: CULTURAL, BIOLOGICAL AND CHEMICAL APPROACHES. Bradley A. Mullens (Department of Entomology, University of California, Riverside, California 92521, U.S.A.)

Culicoides variipennis is a primary vector of bluetongue virus in North America. This species develops in mud at the edges of water sources, particularly when polluted with animal manure. Control programs depend on a sound knowledge of the ecology of the target pest. Cultural methods have been tested experimentally in the field, including water level fluctuation to strand larvae above waterline, reducing the level of pollution to < 300-400 mg COD/liter, and adjusting edge slopes to be steeper than 30 degrees. Biological control has received little emphasis, but a mermithid nematode parasite of the larvae, *Heleidomermis magnapapula*, is occasionally common in the field and recently has been cultured in the laboratory. Pyrethrin, pyrethroids, and temephos have been effective for temporary control when applied to the margins of larval habitats. Ivermectin in host blood will kill adults and affect fecundity and fertility, but only at levels in excess of normal therapeutic doses (200 µg/kg body weight).

DETECTION OF BLUETONGUE VIRUS IN *CULICOIDES VARIIPENNIS* (COQUILLETT) (DIPTERA:CERATOPOGONIDAE) BY DOT-BLOT, ELISA, AND IMMUNO ELECTRON MICROSCOPY. Richard A. Nunamaker, James G. Wigington, James O. Mecham, and Frederick R. Holbrook (USDA,ARS Arthropod-borne Animal Diseases Research Laboratory, P.O. Box 3965 University Station, Laramie, WY, 82071, USA)

Three immunologic procedures were used to detect bluetongue (BLU) virus in specimens of *Culicoides variipennis*, the primary vector of BLU disease in North America. An avidin-biotin complex (ABC) immunoperoxidase system that utilizes nitrocellulose membranes (dot-blot), and an antigen capture enzyme-linked immunosorbent assay (ELISA) detected BLU virus antigen in individual flies 14 days after they had received an infectious blood meal. Immuno electron microscopy (IEM) was used to detect virus particles from salivary glands, fat body and muscle tissue from BLU-infected insects. These methods can be used to discriminate between flies infected with BLU and epizootic hemorrhagic disease virus (EHDV), a closely related orbivirus that often occurs sympatrically with BLU. These procedures were used successfully, for the first time, to identify individual field-collected specimens of *C. variipennis* that were infected with BLU virus.

RE-EVALUATION OF FAINT WING MARKINGS AS THE TAXONOMICALLY IMPORTANT CHARACTER IN THE SUBGENUS AVARITIA OF THE GENUS CULICOIDES (DIPTERA: CERATOPOGONIDAE). Shigeo Kitaoka (Niigata Sangyo University, Kashiwazaki, Niigata, Japan 945-13).

The subgenus Avaritia consists of a unique group in the genus Culicoides which each of all developmental stages has the distinctive morphological character. From epidemiological point of view, the potential vectors or incriminated ones of mmany kinds of veterinary-important animal viruses were reported that they belong to Avaritia, such as C. imicola, C. brevitarsis and their related species in Africa and Japan to Australia through Southeast Asian areas. Previously, as many as about 25 species of Avaritia were recorded from Japan to Australia. Females of several species were differentiated from know similar ones by presence or absence of faint patches or streaks on the wing. Such characteristics of males more vague, but each species manifests specific structure of genitalia. As the result of our careful examination on Zambian species of Avaritia paying attention to formerly missed character, about seven new species similar to C. imicola were made to join in relatively poor African fauna of Avaritia. Almost light-trap samples collected in different localities were found to be mixed populations with C. imicola and several related species.

RESEARCHES ON BLOOD-SUCKING MIDGES IN CHINA (DIPTERA:CERATOPOGONIDAE). Yi-xin Yu(Institute of microbiology and Epidemiology,AMMS,Beijing 100071, China).

A total of 376 species of midges have been found in China up to date including the genera of *Culicoides* (303), *Lasiohelea (45) and Leptoconops* (28). A large-scale investigation on bloodsucking Diptera overcasting 22 provinces has been created since 1982, during which 71 new species of midges were recorded and the bionomics of some of the important populations were studied. The seasonal and day-round activities of some species were also observed in Xizang (Tibet) and Kalakunlum region of Xin-jiang. It has been found That the distribution of *Lasiohelea* was not confined in the southern provinves of China, but stretched widely on to Xizang and Xinjiang. The taxonomic status of *Lasiohelea* was discussed and suggested still as an independent genus based on the structure of their cibarial armatures as well as on their habits of vertebrate preference. A new species, *Leptoconops (styloconops) yalongensis* was recorded in southern Hainan island, and its rhythm of activity was studied.

STUDIES ON THE BITING MIDGES OF THE GENUS FORCIPOMYIA SUBGENUS LASIOHELEA IN TAIWAN. Jih-ching Lien (Institute of Preventive Medicine, Taipei 11513, China)

Forcipomyia (Lasiohelea) taiwana is a pestiferous biting insect in some foothill areas of Taiwan.. During the course of investigation on its ecology, more than 20 taxa belonging to the same subgenus were discovered and described as new to science or new to Taiwan. Of the 24 species known to occur in Taiwan, F. taiwana and F. anabaenae are known to bite man. F. emeishana and F. phototropia were found to bite the toad, Bufo melanosticus, and F. propria to bite the frog, Rana plancyi. F. pungobovis and F. boophila are suspected to bite buffalo. The immature stages of some species were found resting on liverwort, moss and lichen such as Dumortiera hirsuta, Atrichum sp. and Homalia sp., very likely feeding on the algae grown on them. A blue-green alga, Anabaena flosaquae (=Anabaena HA101) was isolated from Atrichum sp: from Wulai, Taipei, and a pure culture of Anabaena HA101 has been successfully used as food for rearing the immature stage of the field collected and laboratory materials. At 25°C the days needed for larval growth were 6-7 days for F. anabaenae and 6-8 days for F. taiwana. Another alga, Gloeocapsa sp. was isolated from the soil material from the breeding ground of F. taiwana and F. phototropia in Lungchi, Tainan. It may constitute a natural larval food.

COMPARATIVE ANALYSIS OF CUTICULAR HYDROCARBONS FROM FIVE MIDGES (DIPTERA:CERATOPOGONIDAE). Jinhua Liu (Military Medical Institute of PLA Guangzhou, Guangzhou510507, China)

The analysis of cuticular hydrocarbons by gas chromatography has been refined as a method of identifying sibling species of medically blood diptera. This paper presents the dorminant ingredients and contents of the cuticular hydrocarbons of five adult females midges Culicoides (Avaritia) obsoletus (Meigen), C. (Av.) sinanoensis Tokunaga, C. (Av.) nujiangensis Liu, C. (Culicoides) pulicaris (Linneaus) and C. (C.) punctatus (Meigen). The results indicated that the number and contents of the dorminant cuticular hydrocarbons of the five midges were different. The clustering results revealed that the Euclid's distances between C. pulicaris and C. punctatus was less among the five midges. The five species of Culicoides can be redivided to two complex:C. obsoletus, C.sinanoensis and C. nujiangensis is one complex, and C. pulicaris and C. punctatus is the another. So, the conclusions from the analysis of ingredients and contents of cuticular hydrocarbon are very similar to that of morphological taxonomy.

FAUNA DISTRIBUTION OF TABANIDAE IN TIBET, CHINA. Rong-man Xu and You-zhi Zhang (Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, China)

On the basis of the papers published in periodicals and the specimens deposited in China, the authors are now in a position to estimate that there are about 3 subfamilies, 5 genera and a total of 50 species (subspecies) of tabanids in Tibet. No specimens of 2 species deposited in China.

Among the 50 species of tabanids, 18 are palaearctic, whereas 32 are oriental. The tabanid fauna in Tibet can be divided to 2 subregions with one belonging to palaearctic region and the other to oriental region: Tibetan plateau subregion with 17 species, and Southern Tibet subregion with 33 species recorded.

With reference to the boundary line of oriental and palaearctic regions in Tibet, we hold that should be delimited at the south slope of Himalaya mountains, beginning from Gyirong-Zhangmu at the middle of Tibet, eastwards to Yadong, Cona, than northwards to Nyingchi, Bomi, and than turning east to Markam of Hengduan mountains, according to the faunistic analyses of Tabanidae collected from Lhasa-Qonggyai-Cona (3500-5000 m), Jomda-Chagyb-Markam (3400-4100 m), Zhangmu-Gyirong (2200-3700 m), Zayu (1700-3600 m), Medog (850-3000 m) and Bomi-Tangmai (2100-2800 m). We considered that the altitude of 3000 m may be reasonable as the boundary, being near to the upper limit of the coniferous-broadleaf forests.

STUDIES ON LEPTOCONOPS KERTESZI COMPLEX IN NORTHWEST AREA OF CHINA. Zengjia Liu, Shuzhen Shi (Institute of Military Medical Sciences, Lanzhou 730020, China)

The studies were made on the morphology of Leptoconops kerteszi complex distributed in Northwest area of China with the method of Tail-organ observation. Thirteen species were found: L. (H.) atuneshanensis, L. (H.) binangulus, L. (H.) borealis, L. (H.) chenfui, L. (H.) conulus, L. (H.) gallicas, L. (H.) mediterraneus, L. (H.) noterophilous, L. (H.) popovi, L. (H.) riparins, L. (H.) tarimensis, L. (H.) tibetensis and L. (H.) triquetrus. The ecology of L. (H.) conulus, L. (H.) noteraphilous and L. (H.) borealis in Leptoconops kerteszi complex was investigated in this experiment. They live in the place of high temperature, low humidity, full (ample) light and little wind and the dance in the air and the bloodsucking are from 10:00 to 17:00 in the day-time. The height period of activity is in the middle of June according to the observation during the May to October. The larvae are found at depth of 2-10cm. (eapecially 2 cm) of the soil of desert, sand beach and sandy soil of moisture.

THE MECHANICAL TRANSMISSION OF PATHOGENIC AGENTS BY TABANIDS. L.D. Foil (Department of Entomology, Louisiana State University Agricultural Center, 402 Life Science Building, Louisiana State University, Baton Rouge, Louisiana USA 70807-1710), C.J. Issel (Department of Veterinary Science, Gluck Research Center, University of Kentucky, Lexington, Kentucky USA 40546)

The magnitude of mechanical transmission of agents by hematophagous arthropods in nature is difficult to assess. Tabanids have been associated with the transmission of over 35 pathogenic agents. Studies on factors that affect interrupted feeding, mixed feeding, and the quantity of agents transferred between hosts will be presented. We have used animal retroviruses (EIAV, BLV and BIV) as models for mechanical transmission, and our studies have been oriented toward describing the factors that contribute to the probability of transmission. ELISA techniques for measuring the amount of blood residue on the mouthparts of tabanids following an interrupted blood meal have been developed. A comparison to in vivo and in vitro radiotracer studies on different groups of insects will be provided. Results of retrovirus transmission trials as they relate to the blood meal residue studies will be presented. Studies regarding the survival of EIAV in insects following parenteral and normal exposure will also be presented.

RECENT ADVANCES IN THE BIOSYSTEMATICS OF TABANIDAE.
John F. Burger, Department of Entomology, University of New Hampshire, Durham, N. H. 03824, U. S. A.

At present (December 1991), 4,230 valid species and subspecies of horse flies have been described in 137 genera, with approximately 20 - 30 new species added annually. Knowledge about the immature stages of Tabanidae (especially taxonomy) continues to lag far behind knowledge of the adult stage, particularly in the species-rich Neotropical and Oriental Regions. Most recent biosystematic research has focused on species of the Oriental, Palaearctic and Afrotropical Regions, and very recent comprehensive studies in the Pacific Region. Many critical areas (moist tropical forest) undergoing rapid change remain little-studied, even though species diversity there is high and many undescribed taxa undoubtedly exist. Recent exceptions are studies in Madagascar and New Caledonia. Estimates of the total fauna described to date vary from nearly 100% in the Nearctic Region to barely 50% in the Neotropical and Oriental Regions.

SIBLING SPECIES OF BLACK FLIES (DIPTERA: SIMULIIDAE). Peter H. Adler (Department of Entomology, Clemson University, Clemson, South Carolina 29634 U.S.A.)

Detailed studies of polytene chromosomes provide the most powerful means of detecting sibling species of black flies. However, morphological and ecological criteria must be used in conjunction with chromosomal data to determine species status for at least 15% of these sibling species. Over the past decade, studies have revealed sibling species at a rate of about four per year in North America; sibling species discovered during this period represent about 20% of the 230 species currently known in North America. At least half of all nominal species on the continent have not yet been examined adequately for sibling species. A direct relation exists between the number of articles published on a nominal species and the likelihood that sibling species are involved. Certain ecological variables, particularly stream size, also provide a strong indication that nominal taxa are composites of sibling species. Studies of sibling species in black flies suggest that similar criteria can be used as predictors of sibling species in other groups of Diptera.

MITOCHONDRIAL DNA AS A SOURCE OF MOLECULAR CHARACTERS FOR SOLVING BLACK FLY SIBLING SPECIES PROBLEMS. Kenneth P. Pruess, Department of Entomology, University of Nebraska, Lincoln, NE 68583-0816, USA.

Mitochondrial DNA was isolated from pooled samples of 300 larvae taken from wild populations of 8 species of black flies. Samples were cut with different restriction enzymes, end-labeled with ^{32}P, fragments separated by electrophoresis, and visualized by autoradiography. Each species had a distinct fragment size pattern. Part of the mitochondrial genome of *Simulium vittatum* was cloned and a restriction map generated. Cloned fragments were used as hybridization probes (Southern blot) to determine polymorphism in individual black flies. Ends of cloned fragments were sequenced. Sequence data permitted identification of specific genes and, in conjunction with published data for other insects, was used to construct conserved primers to amplify portions of the genome (by PCR) of many species. Each species had distinct sequences which provided information for phylogenetic analysis. By amplifying DNA across unique restriction sites, rapid analysis of individual black flies in any life stage can be made in one day without the use of radioisotopes. Amplified DNA is cut with the diagnostic enzyme and results visualized on agarose gels with ethidium bromide staining.

CYTOLOGICAL STUDIES OF *SIMULIUM DAMNOSUM* COMPLEX SPECIES IN NIGERIA. S. A. Bassey (Dept. of Biological Sciences, University of Calabar, Nigeria).

Simulium damnosum Theobald has been found to be a complex of species based on the banding pattern of the polytene chromosomes of their salivary glands. Cytological investigations of members of *S. damnosum* complex in the Savanna and forest climatic zones of Nigeria are being carried out to asses among other things the distribution of the various species in these areas. A high degree of occurrence of *S. sirbanum* (83%) followed by *S. damnosum* (13%) and *S. squamosum* (1%) was observed in the savanna zone. *S. squamosum* occurred most in the forest (13%). In the transition zone, both *S. damnosum* and *S. squamosum* (33%) were observed. Detailed cytological analysis of *S. squmosum* in two forest populations showed in one area a sex linked inversion in the centromere region of chromosome 1. Further analysis of results to determine the population status of *S. squamosum* and the limits of rarest and savannah cytospecies will be discussed.

ROCKY '91: RETURN OF THE BLACKFLIES (DIPTERA: SIMULIIDAE). J.W.O. Ballard (CSIRO, Division of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia), and R.J. Elder (Department of Primary Industries, PO Box 6014, Rockhampton, Qld 4702, Australia).

Blackflies are a common biting insect pest following flooding in north eastern Australia. Yet, there have been few attempts to quantify the severity of an outbreak. This study has used two tent-trap designs and human-bait collections to estimate the numbers of *Austrosimulium pestilens* and *A. bancrofti s.l.* females seeking a blood meal following flooding of the Fitzroy River near Rockhampton. At least 1000 humans required medical attention during the outbreak and cattle losses and death of kangaroos were reported. During this outbreak we considered the parameters that influenced the numbers of flies trapped by portable tent-traps. Generation of models permitted calculation of the fitted trap captures for the number of flies collected under standard conditions. The model can be used to predict changes in the number of trapped and presumably host-finding flies, given environmental change. The number of flies captured by the tent-trap was then linked with the numbers of flies captured in the human-bait experiments generating an equation relating tent-trap captures and human-bait collections. When these tent-traps were placed in the open, collection of 5 flies in 32 min. was equivalent to a human biting rate of about 1/min. We suggest this is a threshold level at which control measures should be introduced to reduce the numbers of biting flies.

DELTAMETHIRN BATH OF DOMESTIC DOG IN THE PRENERNTION OF SANDFLY BITE. Xiong Guang-hua, Jin Chang-fa, Chen Xin-zhong et al. (Institute of Parasitic Disease, CAPM, Shanghai 200025, China)

Reports indicate that the incidence of dog visceral teishmaniasis is rather high in southern Gansu and northern Sichuan. It constituted an important route of human teishmaniasis infection through dog to man and both are inflicted. At present, dogs are raised in the endemic area and in the control of the disease, specific measure shoutd be taken besides the killing of domestic dogs.

This is the first report in the experiment of water solution deltamethrin bath of dogs in the prevention of sandftiy bite.

An experiment of 15 dogs taking the insecticide bath was designated to test the deltamethrin residual insecticide effect. 1 month, 2 monthes and over 2 monthes after the bath, taking any bath of dog put in the mosquito net (dog was fixed in iron cage) with a number of unfed sandfties of Phlebotomus chinensis, from 23,00 to 7,00 hours. Relasing the dog, sandflies examined in the net their were near all found died, only a few living sandflies could be collected. However, all most of the died of poisoning within 1-4 hours. In the control groups, the most rate of died sandfly was only 14.9% within 24 hours.

The result was shown to give good kill sandflies of P. chinensis that the effect at least 2 monthes (over 70 days) in the local area.

Further experiment will be carried out to find the long residual effect of the insecticide lasts on dog body.

PHLEBOTOMUS SICHUANENSIS LENG & YIN, 1983 (DIPTERA:PSYCHODIDAE) AN IMPORTANT POTENTIAL VECTOR OF VL IN SOUTHWESTERN HIGH MOUNTAINOUS AREA OF CHINA. Yan-jia Leng, Ling-min Zhang (Department of Medical Parasitology, Faculty of Medicine, Jinan University, Guangzhou 510632, China)

Leng & Yin (1983) reported a new species P. sichuanensis which was a vector of VL in the northwestern mountainous region of Sichuan Province. Xiong et al. (1990) considered this fly to be a "large type' of P. chinensis on a doubtful and groundless basis.

The authors restudied this subject and concluded that P. sichuanensis is a separate species based on the following facts:

1. DIFFERENT GEOGRAPHICAL DISTRIBUTION: P. sichuanensis was reported distributing in southwest highland above 1000m sea level including Sichuan, Yunnan, Guizhou, Guangxi, Tibet and the Northwest China (southern Gansu and Shaanxi and northern Qinghai).

2. DIFFERENT MORPHOLOGICAL CHARACTERS

3. LIFE HISTORY: The life history of P. sichuanensis (83 days) is much longer than that of P. chinensis (59 days).

4. GENETIC ANALYSIS: The isoenzymic analysis showed that PGM of P. sichuanensis is different to that of P. chinensis. The genetic identity and genetic distance between them are 0.702-0.783 and 0.245-0.353 respectively.

PATTERNS OF HUMAN DECOMPOSITION WITH SPECIAL REFERENCE TO THE ROLES OF INSECTS. M. Lee Goff, Department of Entomology, University of Hawaii at Manoa, Honolulu, Hawaii, USA.

Decomposition is a continuous process which may be divided into a series of reference stages based on physical appearance and, to a lesser extent, the various insects present on the remains. The changes in the remains due to the decomposition processes will be discussed and illustrated. Examples of the varied roles of the insects in this process, ranging from those feeding directly on the remains through the parasites and predators, will be presented.

LENGTH OF TIME SINCE DEATH: EFFECT ON ATTRACTION AND OVIPOSITION OF MIDSUMMER BLOW FLIES (DIPTERA: CALLIPHORIDAE) IN MISSOURI, U.S.A. Robert D. Hall and Kathy E. Doisy (Department of Entomology, 1-87 Agriculture Building, University of Missouri, Columbia, Missouri 65211, U.S.A.

The succession of necrophilous insect species at carrion is well known and fundamental to their forensic use as medicocriminal indicators. Corpses dead differing lengths of time attract different insect species, but no studies have focused strictly on the time element. As a practical example, will a corpse dead three days, but protected from insect activity by being enclosed in an automobile trunk, attract blow flies identically to the manner in which a freshly dead corpse will? We describe an experiment wherein a series of animals (Leghorn chickens) was killed at the same time, with some exposed immediately to blow fly activity and others protected from flies by 0.8-mm-mesh screening and aluminum wrap. The latter chickens were exposed out-of-doors to natural populations of blow flies 1, 2, 3, or 4 days postdeath. Qualitative differences in blow fly attraction and oviposition were measured by trap catches over the corpses and rearing samples of eggs deposited thereon.

FORENSIC ENTOMOLOGY: AN ECOLOGICAL PERSPECTIVE. Jeffrey D. Wells, (Department of Entomology, Louisiana State University, Baton Rouge, LA, 70803-1710, USA).

Medico-legal entomology lacks a strong base in theory and associated experiments. Carrion arthropods, though, have long been the subject of detailed ecological theory and research. The observations and techniques of carrion ecologists can help forensic entomologists deal with the effects of biological variation and sampling technique. Recent advances in this field will be reviewed and suggestions made for future work.

DEVELOPMENTAL RATES OF FLY LARVAE RELATED TO FORENSIC PROBLEMS. K. Nishida (Department of Pathology, Public Health Research Institute of Kobe City, 4-6, Minatojima Nakamachi, Chuo-ku, Kobe, Japan)

The estimation of PMI by fly larvae indispensably needs ability to identify exact species of the larvae. Kano reported many papers on the fly larvae of medical importance. Since then the 1st, 2nd and 3rd instar larvae of most fly species could be identified rather easily.

In this study, 2 species from family Sarcophagidae and 5 species from family Calliphoridae were examined. The larvae were kept in the laboratory chamber at 15, 20, 25, 30 and 35 C. The samples of larvae were picked up at the same hour every day, and body length and weight were estimated after killed with hot water (about 70 C). Also the periods from ovi- or vivi-position (Sarcophagidae) to pupation and eclosion were measured.

The results are as follows: 1) the developmental rates from egg to early stage of the 3rd instar agree with index curve as expected, and they are formulated; 2) the thermal constant and the threshold of development were obtained; 3) the succession of pupal colour change is not useful for PMI; 4) the body weight is not suitable for PMI, because its range is very wide and its mean number varied; 5) the flies grow in the species-specific way; 6) the method of calculation of PMI at optional temperature is proposed.

ENTOMOTOXICOLOGY: EFFECTS OF DRUGS AND TOXINS ON DEVELOPMENT OF DIPTERA LARVAE AND THEIR UTILITY IN DRUG DETECTION

Francesco Introna Jr MD
Institute of Legal Medicine, University of Bari, Italy

Entomotoxicology is a new branch in forensic entomology. Until some years ago the diptera larvae were used in forensic sciences to provide useful information on the minimum time of death, on the previous location of the corpse and on its geographical provenience.

Recently the diptera larvae growth on a corpse have been observed under different prospective.

It has been realized that feeding on a corpse, the diptera larvae can also give useful indications on previous intoxications of the body and then on its cause of death.

In the seventies Nuorteva discussed the possibility to use the emerging flies to determine the pollutant content, such as mercury, of a corpse.

In the eighties Bayer used the diptera larvae found on a badly decomposed corpse as a source material for toxicological analyses. Qualitative and quantitative toxicological researches confirm, later, the possibility to use the larvae recovered from a corpse as suitable specimens for the analyses of morphine, cocaine, organophosphate, benzodiazepine, phenothiazine, antidepressant and barbiturates.

In the nineties Goff reported that heroine and cocaine can accelerate the rate of larval development. The differences were sufficient to alter the estimation of time of death based on larval development.

In this revue the case-reports, the results of the specific researches and some suggestions to develop further in the area of forensic entomo-toxicology are presented.

ENTOMOLOGICAL EVIDENCE FROM EXTENDED POSTMORTEM INTERVAL CORPSES. Neal H. Haskell, RPE, Michael A. Clark, PhD, MD and Della C. Cook, PhD., Department of Entomology, Purdue University, West Lafayette, Indiana 47907, USA.

Two mummified corpses were discovered in a residence when investigators responded to a request for investigation of a 69 year old male who had not been seen within the previous few days. One corpse was found covered in a bed in a bedroom at one end of the home and had been slightly skeletonized by insect feeding. The extent of skeletonization was found primarily in the head and upper torso area, but the corpse had not been completely skeletonized. Several hundred empty Calliphoridae (Blow Fly) puparia were found. The second corpse was discovered in bed in a second bedroom at the opposite end of the house and showed minimal skeletonization, but complete mummification.

The corpse which had partial skeletonization and contained the mass of puparia was estimated to have died in the fall (October), while the one without insect feeding was placed in early winter (late December to early January). While not being able to place the year, these dates were confirmed by the physical evidence at the scene.

Also, a brown, stringy type material was found in large quanities in association with the soft tissues of both corpses. Upon analysis, this material was discovered to be fecal material from larvae of one of the dermestid beetles (Dermestiade; *Dermestes lardarius*).

TRAINING PROGRAMS IN FORENSIC ENTOMOLOGY. Ralph E. Williams, Department of Entomology, Purdue University, West Lafayette, Indiana 47907, USA.

There is a growing interest in the entomological aspects of death scene investigations. Consequently, there is an increasing need for the proper training and awareness of the science of forensic entomology. For the general public, forensic entomology can be addressed with appropriately prepared news releases, TV-radio interviews, civic group presentations, and seminars presented to high school and college students. For the scientific community, seminars can be presented at scientific meetings, guest lectures made in selected courses, and forensic research findings and case studies published in scientific journals. On addressing the criminal justice community, seminars and workshops can be conducted. These should encompass the basics of entomology, applications of forensic entomology, and the materials and methods used in forensic entomological investigations. Articles in trade publications and preparation of procedural guides can enhance the training program and can be used as reference materials.

EFFECT OF AMITRIPTYLINE IN DECOMPOSING TISSUES ON DEVELOPMENT OF *PARASARCOPHAGA RUFICORNIS* (DIPTERA: SARCOPHAGIDAE). M. L. Goff, W. A. Brown (University of Hawaii at Manoa, Honolulu, Hawaii 96822 USA) & A. I. Omori (Medical Examiner, City & County of Honolulu, Honolulu, Hawaii 96817 USA)

Larvae of the flesh fly *Parasarcophaga ruficornis* were fed on rabbit tissue from animals given lethal, sublethal and zero (control) doses of amitriptyline, a widely prescribed antidepressent. Growth rate and developmental time at the varied dosages are compared with larvae fed on tissues from a control animal and differences of developmental rates and puparial mortality recorded. Differences in rates of development have been shown to be statistically significant in studies on drugs of abuse, which could result in errors of postmortem interval if based solely on normal developmental rates. Differences, in the presence of the widely prescribed amitriptyline, are presented and add to our knowledge of postmortem interval estimation when that drug is present in tissue.

XIIS-9 The Danger of International Transport of Arthropods and Arthropod-Borne Diseases with Medical and Veterinary Importance

CLIMATIC VARIATION AND ITS IMPORTANCE IN REDISTRIBUTION OF ARTHROPOD VECTORS. J.Eric Hillerton (Institute for Animal Health, Compton, Berks, RG16 ONN, UK)

There is continual geographical redistribution of arthropod vectors of disease. Successful establishment in new environments varies with the rate of migration (or transport of the vector), the availability of a suitable host, an amenable environment for survival and multiplication of the vector population, and the relative absence of competing species, predators and control techniques. Variation in any of these factors leads to significant changes in the rate and extent of redistribution. There may be phases of temporary redistribution which are most readily converted to permanent establishment if the ecology is suitable for population growth.

Several scenarios of changing redistribution of arthropod vectors allowed by changes in local and more widespread climate have been described recently and are now the subject of modelling studies. The overall principles will be considered and the consequences for disease examined.

MYIASIS OF COCHLIOMYIA HOMINIVORAX, A SPREADING PEST FROM THE NEW WORLD TO AFRICA. S. E. Kunz, Knipling-Bushland U.S. Livestock Insects Research Laboratory, ARS-USDA, Kerrville, TX U.S.A.

The screwworm, Cochliomyia hominivorax (Coquerel), has been a destructive pest of warm-blooded animals distributed throughout the tropical and subtropical areas of North America and South America. Until recently, this pest had been confined to the New World. In 1987 this pest was introduced into Libya where it became a serious problem on a wide range of animal species and humans. Becoming established in Libya, it became an instant threat to all of Africa, southern Europe and Asia. Fortunately, its distribution was contained, and the pest was eradicated in 1991 using the sterile male technique under the direction of the UN's FAO.

THE CAMPAIGN TO ERADICATE THE NEW WORLD SCREWWORM FROM NORTH AFRICA, D.A. Lindquist, W. Klassen, M. Abusowa and A. Van Der Vloedt (Screwworm Eradication Center North Africa, Tripoli, Libya)

In 1988 Cochliomyia hominivorax (Coquerel), the New World screwworm (Diptera: Calliphoridae), was found to be established in Libya. 26,000 sq. km. became infested. An eradication campaign was organized under the leadership of FAO in cooperation with the Govt. of Libya. The strategy included prevention of spread of all infested animals, treatment of wounds with coumaphos and release of sexually sterile flies at a rate of about 1,000 per sq. km. per week. Flies were reared and irradiated in Mexico and shipped by air to Tripoli. Advantage was taken of the cold winter of 1990/1991 to mount a strong campaign even before the onset of weather favourable for development of the parasite. In 1990 the number of infested animals was 12,068, but only 6 in 1991. The last case was reported on 7 April, 1991. Releases of sterile flies were terminated in October, 1991, and intensive surveillance was planned through June, 1992. During 1991 more than 30 million animal inspections were conducted, and more than 50,000 wounds were treated. In 1990 there were less than 5 percent as many cases of myiases by other species as by C. hominivorax. The mean temperature on the coastal plain during the three winter months in 1990/91 was 12.6 C, but in the interior highlands the mean temperature fell below the survival threshold of 9.7 C.

ERADICATION OF HYPODERMOSIS IN NORTHERN EUROPE AND THE PROBLEMS ARISING FROM INTERNATIONAL LIVESTOCK MOVEMENTS. D. W. Tarry (Central Veterinary Laboratory, Weybridge Surrey KT15 3NB Great Britain)

Eradication in the case of bovine hypodermosis is facilitated by the that fact in Northern Europe this is a parasite with no significant alternative hosts and the early larval stage using systemic treatments. Of these the ivermectin group now offers the best hope for eradication, being also 100% effective even at very low dosages. With the added advantages of geographical isolation and centralised administration of eradication measures, Britain now appears to be close to total eradication of hypodermosis, with no positive results from serological tests on 227,000 blood samples in spring 1991 and from a further 150,000 tested in the autumn. Co-ordination of eradication effort across local and national boundaries will be essential in achieving successful results in a European context. Other warble species affecting deer and goats are equally host-specific, and their control will offer fewer problems owing to their more localised distributions.

THE PROBLEM OF INTERNATIONAL TRANSPORT OF PARAFILARIASIS : RISK EVALUATION AND PREVENTIVE MEASURES. Jørgen B. Jespersen (The Danish Pest Infestation Laboratory, Skovbrynet 14, DK-2800 Lyngby, Denmark).

Parafilariasis has shown to be a danger of international and national livestock movements. The parasite *Parafilaria bovicola* (Tubangui 1934), a filarial nematode affecting cattle, gives rise to condemnation losses of meat in affected animals at slaughter. Licking flies of the genus *Musca* are known to serve as vectors of *P. bovicola*. To determine the distribution and the abundance of the vector *Musca autumnalis* (De Geer), field surveys have been conducted in Denmark. In the light of these results, the occurrence of the disease and the vector(s) in Scandinavia and in other parts of Europe will be discussed. Methods for risk evaluation and possible preventive measures will also be mentioned.

TRANSPORT OF TICKS AND DISEASES BETWEEN EOURPE, AFARICA AND THE NEAR EAST. A. Liebisch (Institute Parasitology, Buenteweg 17,D-3000 Hanover, Germany)

A large number of viruses, rickttsiae, spirochetes and protozoa were isolated from ticks which are regularly transported between Europe, Africa and the Near East. Every year in full 5.000 millions of birds from Europe migrate to Africa south of the Sahara for overwintering. Out of 10.000 southwards migrating birds 10 to 20% were infested with Ixodes ricinus, carrying 3 ticks per bird. On their migrating routes and resting sites in the mountains in Syria and Tunesia this vector tick of Borrelia burgdorferi was found to establish breeding colonies. Migrating northwards in spring, Hyalomma marg. marginatum and Haemaphysalis leachi were recorded from birds and even from cattle in Germany, Denmark, Sweden, England and other places. Rhipicephalus sanguineus is a Mediterranean tick species closely related to dogs. By travelling activities of European tourists ticks are very often transported with tourists and their dogs. Tick colonies are established in dog kennels and houses in many European cities north of the alps. Increasing numbers of imported cases with dog babesiosis were seen. The first autochthonic infections of babesiosis transmitted by Dermacentor reticulatus could be observed in Germany recently.

INTERNATIONAL TRANSPORT OF TICK-BORNE DISEASES OF ANIMALS: EXAMPLE OF HEARTWATER IN THE WESTERN HEMISPHERE. *Gerrit UILENBERG (IEMVT-CIRAD, 94704 Maisons-Alfort, France)*

Heartwater (***Cowdria ruminantium*** infection) has originally been introduced into the western hemisphere by the transport of African cattle infested with ***Amblyomma variegatum***. It is now known to occur on at least 3 Caribbean islands, but several more islands are infested with heartwater-free populations of ***A.variegatum***. Transport of heartwater and other tick-borne diseases may occur in various ways:

* By movements of infected hosts, which infect populations of the known African vector ***A.variegatum*** occurring on various Caribbean islands.
* By movements of infected hosts, which infect populations of proven experimental American ***Amblyomma*** vectors occurring on the mainland of North, Central and South America.
* By movements of animals carrying infected ticks to islands or regions free from suitable tick vectors. Domestic livestock presents the greatest danger, as the rare infected nymphs transported on birds are unlikely to establish both the infection and a viable vector population.

The extent of the danger of transporting heartwater between islands and continents is better appreciated since it is known that recovered ruminants remain long-term carriers. Eradication of the focus in the western hemisphere is more urgent than ever.

INTERNATIONAL TRANSPORT OF TICK-BORNE DISEASE IN AFRICA: THE EXAMPLE OF HEARTWATER. Conrad E. Yunker (Veterinary Research Institute, Onderstepoort, South Africa)

The spread of ticks and tick-borne disease agents of man and animals is determined in large part by the activities of man. These activities include translocation of livestock and game animals, tick and disease control programmes, and precautionary measures.

Notwithstanding, other natural factors are also responsible for transport of these pests and pathogens, including animal migrations and dispersal through the agency of climatic events.

Specific examples, including heartwater, East Coast fever, babesiosis, African tick-typhus and Congo-Crimean haemorrhagic fever, are discussed in the context of transport, establishment, control and eradiction.

VARROA JACOBSONI - AN EXAMPLE OF A SUCCESSFULLY SPREADING PARASITE

W. Ritter, (Tierhygienisches Institut Freiburg, D-7800 Freiburg FRG)

The mite Varroa jacobsoni now presents serious problems in world beekeeping due the parasitic relationship with Aois mellifera. The mite was originally a parasite of Apis cerana, the eastern honeybee. It succeeded in parasitizing the western honeybee Apis mellifera when this bee came into contact with A. cerana. Both honeybee species are breeding in hollows. The microclimate inside of their nest remains, for the most part, constant. This was the essential prerequisite which enabled the mite to spread throughout, independent of the external climatic zones. With the exception of the natural limits of honeybee distribution in the north and south, Varroa has spread throughout all continents. Only Central and South Africa, as well as the oceanian region, have not been affected up to now.

MALSIM, A COMPUTER SIMULATION MODEL FOR MALARIA TRANSMISSION BY ANOPHELINE MOSQUITOES. D.G. Haile (Medical and Veterinary Entomology Research Laboratory, Gainesville, Florida, USA)

MALSIM, is a computer program for simulation of anopheline mosquito population dynamics and falciparum malaria transmission to a human population. The vector population model uses a dynamic life table and includes the effects of temperature, saturation deficit and rainfall on major biological parameters. The disease transmission model includes simulation of vector-host interactions for transfer of parasites between infective and susceptible individuals, temperature dependent development of the parasite in the vector and an age structure for development of the parasite in humans. The model program provides for simulation of various vector control measures. The model software is written in Microsoft Professional Basic for interactive operation on IBM or compatible microcomputers.

COMPUTER SIMULATION OF THE POPULATION DYNAMICS, ECONOMICS AND MANAGEMENT OF *A. AMERICANUM* WITH LSTSIM. G.A. Mount, D.G. Haile & D.R. Barnard (Medical and Veterinary Entomology Research Laboratory, Gainesville, Florida, USA)

A model, LSTSIM, is a computer program that simulates the population dynamics, economics and management of the lone star tick, *Amblyomma americanum*. LSTSIM provides a tool to study the effects of weather, habitat and density and type of host animal on tick population growth. Population densities, seasonal activity and growth rates over a wide range of geographic areas and weather pattern were used as an indicator of model acceptability during calibration of biological parameters. LSTSIM was validated by comparison of simulated and observed population data from Oklahoma, Kentucky and Tennessee. LSTSIM was used to study the relationship between densities of the principal host, *Odocoileus virginianus*, and tick population growth. The model includes effects of control technologies on tick population and the economics of tick control. The model can be used to develop management strategies for *A. americanum.* in wildlife and beef cattle ecosystems. The model software is written in Microsoft Professional Basic for interactive operation on IBM or compatible microcomputers.

MODELLING THE REDISTRIBUTION OF ARTHROPOD VECTORS OF ANIMAL DISEASE IN WESTERN EUROPE. J.Eric Hillerton, J.D.Austin, R.van Es (Institute for Animal Health, Compton, Berks, RG16 0NN, UK)

Several arthropod vectors of disease are ubiquitous to western Europe, and various others challenge regularly, although abundance varies greatly as does the incidence of the various diseases they transmit. Preliminary models allowing prediction of redistribution of *Hydrotaea irritans* (Fall.), Culicoides sp. and *Ixodes ricinus* (L.) in response to changes in climate affecting population dynamics and agricultural strategy are being produced. The models are being developed on existing field data collected over 10 years and will be refined from future field studies and climatological predictions.

A COMPUTER MODEL TO SIMULATE THE POPULATION DYNAMICS OF *GLOSSINA PALPALIS*. W. Takken (Department of Entomology, Agricultural University, PO Box 8031, 6700 EH Wageningen, The Netherlands), D.G. Haile (Medical and Veterinary Entomology Research Laboratory, USDA-ARS, PO Box 14565, Gainesville Fl. 32604, USA)

The distribution of tsetse flies in Africa is determined by climatic factors, mainly temperature and saturation deficit. This knowledge has been used to develop a simulation model of the population dynamics and natural distribution of *Glossina palpalis*, a group of important pest insects in much of West and Central Africa. The model uses a life cycle with daily inputs and outputs of cohorts of flies, all subjected to the same climatic variables. Density dependent factors in the pupal and adult life stages are included in order to simulate the effect of other natural population regulating mechanisms. The model was validated against field data collected in the Ivory Coast and Nigeria. Simulation of the tsetse population in 40 different locations situated within or on the edge of the known distribution of *G. palpalis*, showed a reasonable degree of accurateness of the model. The results suggest that in locations with an optimal habitat and climate for *G. palpalis*, the lack of hosts is the principal factor limiting tsetse population growth.

ADAPTATIONS AND EVOLUTIONARY STRATEGIES OF ARTHROPODS FOR ECTOPARASITISM: INTRODUCTION. K. C. Kim, Frost Entomological Museum, Department of Entomology, The Pennsylvania State University, University Park, PA 16802 USA

Adaptive Strategies of ectoparasitic arthropods will be discussed as the introduction to the symposium.

ADAPTATIONS OF LARVAL TROMBICULID MITES TO HOST PARASITOPE (ACARI: TROMBICULIDAE). M. Lee Goff, Department of Entomology, University of Hawaii at Manoa, Honolulu, Hawaii, USA.

The larval Trombiculidae, or chiggers, are typical "field" ectoparasites,showing a wide range of host species recorded for many individual chigger species. Within this framework, a specificity for parasitope or attachment site exists which is in many cases constant at the generic level. This specificity for parasitope is reflected in modifications of structures involved in attachment of the chigger to the host (cheliceral blade and palpal claw) or in protection of the exposed idiosoma (development of pygosomal plates and setae). Analyses of these adaptations will be presented based on large collections from Papua New Guinea and the Philippine Islands.

ECOLOGICAL ADAPTATIONS OF TEMPORARY ECTOPARASITES WITH EMPHASIS ON TICKS. Glen R. Needham (Acarology Lab, Department of Entomology, The Ohio State University, Columbus, Ohio), Richard E. Lee, Jr. (Department of Zoology, Miami University, Oxford, Ohio), Pete D. Teel (Department of Entomology, Texas A&M University, College Station, Texas)

Ticks spend the majority of their lives off the host (>90%). Off-host survival success is influenced by water conservation (integumental permeability), active water-vapor uptake, water-pool size, tolerance of water loss and temperature extremes, metabolic rate, and behavior. In our presentation, we discuss the relative importance of each of these factors in ixodid tick survival using three very different *Amblyomma* species as examples. Understanding off-host survival strategies is critical to medical and veterinary entomology because these arachnids serve as both reservoir and vector of many kinds of disease organisms. Also, management strategies of off-host stages, especially where modelling is to be employed, requires a thorough knowledge of water balance, energetics and temperature extreme tolerance for the tick.

EVOLUTIONARY PLASTICITY OF ECTOPARASITES: DISCUSSION AND CONCLUSION. K. C. Kim, Frost Entomological Museum, Department of Entomology, THe Pennsylvania State University, University Park, PA 16802 USA

Adaptive strategies for evolution of the arthropod ectoparasitism are summarized and discussed.

MORPHOLOGICAL ÀDAPTATIONS OF MYOBIID MITES (PROSTIGMATA, ACARI) ON MAMMALS. K. Uchikawa, (Department of Parasitology, Shinshu University School of Medicine, Matsumoto 390, Japan)

Ancestors of myobiids that are thriving presently on Marsupialia, Insectivora, Chiroptera and Rodentia are thought to have evolved from predacious mites. On acquisition of the parasitic life, they took the 2 different modes of adaptations, one on Marsupialia and the other on the other hosts. Then, probably by convergent evolution, their strong dependency on hosts' hairs was accomplished in both groups as in the present forms through the specialization of legs I and idiosomal elongation. Diverse bilateral asymmetries that are associated to some extent to the modification of legs I are unusually common among some groups of myobiids. Although the survival value of any kind of asymmetries is not evaluated, some of them have infallibly worked upon the reproductive isolation among allied forms and brought about a rich myobiid fauna. There are remarkable variations in some legs and genitalia among congeners, yet their adaptational significance is unknown. However, those diverse and serial modifications serve as the basis of consideration on the evolution and zoogeography of myobiids with relation to those of their hosts.

HOST-ODOUR RESPONSES IN THE *ANOPHELES GAMBIAE* COMPLEX. W. Takken T. Dekker, Y. Van Den Hork and Y. Wijnholtz (Department of Entomology, Agricultural University, PO Box 8031, 6700 EH Wageningen, The Netherlands)

The *Anopheles gambiae* complex consists of six siblings with widely different host preferences. It is not known which factors cause the observed differences in this behaviour. To investigate the nature of these differences we studied the host-seeking behaviour of *An. gambiae s.s.*, a mostly anthropophilic sibling, and *An. arabiensis*, which has a more opportunistic feeding behaviour. Human odours were released in a large windtunnel and mosquito behaviour was recorded using direct observations and video recordings. Significant differences in flight and settling behaviour were observed. In particular expired air and carbon dioxide caused a greater plume orientation as well as source location behaviour in *An. arabiensis*, while skin emanations caused differences in orientation and flight speed. It was further found that acetone, 1-octen-3-ol, 2-ethyl-1-hexanol and 4-methyl-phenol caused behavioural responses which were significantly different for each of the two siblings under study. Possible reasons for the observed differences are discussed.

FIELD APPLICATION OF HOST ODOR ATTRACTANTS FOR CONTROL OF MOSQUITOES AND OTHER BITING FLIES. D.L. Kline, (Medical and Veterinary Entomology Research Laboratory, USDA/ARS, P.O. Box 14565, Gainesville, FL 32604 USA)

Increased concern with insecticide resistance and environmental contamination has provided the impetus to develop alternative control strategies for blood feeding mosquitoes and biting midges. Recent research on tsetse attractants has revealed the existence of a variety of host produced kairomones (1-octen-3-ol, various phenols, butanone and acetone) which have been successfully incorporated into a tsetse management program. Inspired by this program's success, a research project to evaluate these newly discovered kairomones as well as previously identified mosquito attractants (carbon dioxide and lactic acid) for their surveillance and/or control potential for mosquitoes and biting midges was initiated in 1986. The data obtained so far indicate that the degree of attractancy of these kairomones depends on the target species and its physiological and chronological age. Release rate and blend of semiochemicals are also important factors. The combination carbon dioxide and 1-octen-3-ol appears to be the most promising for use in removal trapping strategies.

MOSQUITO FLORAL ATTRACTANTS AND NECTAR FEEDING. Woodbridge A. Foster, Robert G. Hancock, Wee L. Yee (Department of Entomology, Ohio State University, Columbus, OH 43210, U.S.A.)

Plant sugar is an integral part of the female diet of most mosquito species. This sugar, available in nectaries, fruits, saps, and honeydew, supplements the energy derived from vertebrate blood and often is essential for survival, flight, and fecundity. Sugar is taken throughout adult life, sometimes several meals per gonotrophic cycle. Our recent research indicates that sugar feeding and blood feeding are mutually inhibitive, yet both feeding activities occur during the same part of the diel cycle, so only one type of food is likely to be taken within a single window of opportunity. Therefore, the use of plant-related sugar attractants for trapping mosquitoes might be a reasonable supplement or alternative to the use of animal-related kairomones. A possible deficiency is the apparent subordination of plant stimuli to animal stimuli when both are presented simultaneously. This clearly is not the case in species requiring sugar before seeking blood and in situations where the plant kairomone is suffiently strong. Many sugar-related plant extracts have proven to be attractive in the laboratory and are awaiting component analysis or field trials.

OVIPOSITION ATTRACTANTS OF MOSQUITOES: POTENTIAL IN SAMPLING AND CONTROL PROGRAMS.

M. S. Mulla, J. W. Beehler, J. G. Millar. Dept. of Entomology, University of California, Riverside, CA 92521 USA

Various species of mosquitoes utilize a number of physico-chemical cues to initiate the oviposition process and bring it to completion. It is a well known fact that different species of mosquitoes discern and locate specific habitats where they typically oviposit and the immatures develop. Once the gravid females find the general habitat, then a complex of chemical and physical factors influence oviposition behavior. Semiochemicals produced by the action of microbial agents degrading organic matter provide important cues for oviposition by gravids. Additionally, physical factors such as color of the substrate, proximity to vegetational stands, water and light intensity further modify the oviposition behavior.

A combination of infusions, semiochemicals and physical factors were studied to assess the ovipositional activity of *Culex quinquefasciatus* in an urban area. Color of substrate in the trap, along with authentic semiochemicals, influenced the ovipositional activity of this mosquito. Using these factors, spatial and temporal distribution of oviposition, circadian oviposition rhythms and other attributes were studied.

The use of these physico-chemical cues will provide a powerful tool for monitoring gravid and infected mosquitoes.

IDENTIFICATION OF HOST ODOUR ATTRACTANTS FOR TSETSE FLY AND NEW WORLD SCREWWORM. Alan Cork, P.S. Beevor and D.R. Hall (Natural Resources Institute, Chatham Maritime, Kent, ME4 4TB, U.K.)

Tsetse flies, *Glossina* spp. are obligate blood feeders and New World screwworms, *Cochliomyia hominovorax*, are obligate parasites. Both rely on olfactory and visual cues to locate their mammalian hosts. Effective odour baits can greatly improve the performance of traps for adult flies to replace sentinel animals used for surveys. These baits can also be used to control the flies by "lure-and-kill" approaches. Current work on detection and identification of the attractive components of various host odours is described.

Host odours have been collected by air entrainment of host volatiles and solvent extraction of attractive materials such as urine or wound fluids. The extracts were screened by electroantennography linked to a gas chromatograph and electrophysiologically-active compounds were characterised on the basis of their mass spectra. Synthetic compounds were tested for behavioural effects in a laboratory windtunnel and in the field.

The results of this work indicate considerable similarity between the compounds present in odour sources that attract both tsetse fly and New World screwworm; 1-octen-3-ol, indole, naphthalene, phenol, 3- and 4-methylphenol and a range of carboxylic acids were present in cattle residues and screwworm wound fluids. However, potent attractants of tsetse fly such as 3-propylphenol were not observed in screwworm wound fluids.

PROSPECTS FOR THE FURTHER IMPROVEMENT OF ODOUR BAITED TARGETS TO CONTROL TSETSE FLIES.

S. J. TORR, Tsetse & Trypanosomiasis Control Branch, Harare, Zimbabwe

Odour-baited targets are currently being used to control tsetse flies (Glossina spp.) over some 8000 km² of Zimbabwe. The targets consist of panels of cloth impregnated with deltamethrin and baited with a blend of acetone, octenol, 4-methylphenol and 3-n-propylphenol. Tsetse are attracted to the target where they are induced to contact it and thereby pick up a lethal dose of insecticide. To further improve the efficacy of targets, studies are being carried out to (i) increase the longevity of the insecticide and odour-dispensers, (ii) to reduce the capital and maintenance costs of targets and (iii) to identify additional attractants. The results indicate that the insecticides and attractants can be formulated to have an effective life of at least a year, that the cost of targets can be halved without any reduction in their efficacy, and that unidentified attractants are present in ox and possibly warthog odours. Field studies suggest that these unidentified attractants can at least double the numbers of tsetse attracted to a target.

ODOUR PLUMES AND HOST FINDING IN TSETSE FLIES.

John Brady, Nigel Giffiths, Mike Packer and Gabriella Gibson (Biology Dept., Imperial College, Silwood Park, Ascot, Berks - SL5 7PY - U.K.)

The modal windspeed in typical tsetse habitats is ~0.3 m s^{-1}, at which speed odour plumes change direction at ~15° s^{-1}. As a result the direction of movement of packets of odour-containing air extrapolates only weakly back towards the source (host): only 15 m away the wind direction may be biased towards the source (± 30°) for <50% of the time, and may point >90° away from it for ~25% of the time.

This must pose problems for tsetse flies locating hosts by upwind anemotaxis. However, because the straightness of the wind improves with windspeed (correlating positively up to ~0.8 m s^{-1}), they should find hosts more easily with increasing windspeed. We tested this in Kenya by catching, with a two-sided electric net, flies that arrived at an odour-baited visual target with a recording anemometer running next to it.

Arrival rates of Glossina pallidipes (corrected for time of day), correlated positively with windspeed up to ~0.7 m s^{-1} (r = 33%), but levelled off above that (by which point the wind runs effectively straight), and as the proportion of the wind running at >0.5 m s^{-1} increased from 10% of the time to 50%, the proportion of the flies arriving in upwind flight increased likewise. We also measured flight times up such odour plumes in relation to windspeed and variability, and found that the faster the wind, the more successfully (though not necessarily the faster) tsetse flies found odour sources - presumably because the odour plumes are then straighter and thus more readily navigable.

MALARIA TRANSMISSION IN A REMOTE VILLAGE LOCATED NEAR THE MALAYSIAN-THAILAND BORDER. A. Abu Hassan, Wahab A. Rahman and M. Razha Rashid* (School of Biological Sciences and *Centre for Off-Campus Studies, Universiti Sains Malaysia, 11800 Penang, Malaysia

Blood from most the residents of Kampong Bongor in the north peninsular Malaysia bordering Thailand was visually examined for malaria parasites for 2 years. Plasmodium falciparum, P. vivax and mixed infections occurred among the villagers, but falciparum seem to be more common.

From 24 monthly collections of Anopheles mosquitoes, 16 species were caught of which An. aconitus comprised 43.5% of the total catch, followed by An. maculatus, An. kochi, An. philippinensis, An. vagus and An. barbirostris respectively. The remaining 10 species generally seemed to be less dominant. An. maculatus seem to be the main vector with midguts infected with oocysts. An. aconitus, An. kochi and An. philippinensis were found to be infected with oocysts which appeared healthy and may be secondary vectors. Changes in seasonal abundance and biting cycles of An.maculatus, An. kochi, An. aconitus and An. philippinensis were discussed.

Ground pools, fish ponds, fallow ricefields and stream margins were the main larval breeding habitats of the dominant Anopheles species.

ASPECTS OF ECOLOGICAL SEPARATION OF THREE COEXISTING Glossina SPECIES IN KENYA.

M.L.A. OWAGA, THE INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY (ICIPE), P.O. BOX 30772, NAIROBI, KENYA

In the humid and sub humid coastal zone of Kenya, 3 tsetse fly (Glosssina) species, Glossina pallidipes, G. austeni, and G. brevipalpis co-exist ecologically, in low to medium densities. A study was conducted to determine their habitat preference, feeding habits and the extent to which each is infected with trypanosome parasites. The main objective was to determine the ecological separation strategy between them. Both G. pallidipes and G. austeni belong to the morsitans group. Members of that group are mainly savanna dwellers. But G. austeni is an exception and occurs exclusively in the humid forests of the coast. G. pallidipes is most adaptable, it occurs in savanna woodlands, semi desert areas, forests, high altitude plateaus and in the coastal dense thickets. G. brevipalpis is a member of the fusca group of Glossina, and is typically a forest and dense thicket species. It also occurs inland as well as along the coast. However, like all members of that group it is crepuscular and flies about at dusk and dawn and is almost totally inactive during day time. This is one of the factors that separates it ecologically from the rest. The results also showed that the three species have different rates of trypanosome infection, with G. austeni showing significantly greater infection rates than the others. G. brevipalpis was the least infected.

STUDIES ON VARIATION PATTERN OF VIVAX MALARIA PREVALENCE AND ITS RELATIONSHIP WITH POPULATION CHARACTERISTICS OF ANOPHELES SINENSIS. TIANBAO FAN, Zhaolun Wang and Tainmin Zhen (Shandong Institute of Parasitic Diseases, Jining, Shangdong 272133, China)

Prevalence of malaria was found to be relevant with vector and environmental factors in our study performed in a lake-side rice-growing area of southern Shandong in 1975-1990. The disease rate increased in years with high density and parous rate of vector, falling back of peak density period, An. sinensis composition of above 20. 4% in whole mosquito population. Malaria was prevalent at a periodic cycle of about 10 years. Heavy prevalence was mostly in years with peak solar activity and 1-2 years afterwards, and with high air temperature and plentiful rainfall. Vector density and parous rate increased with high air temperature and aboundant rainfall, and they are also relevant with ground water collection.

AN EFFICIENT TEST FOR LOCATING FILARIASIS ENDEMIC AREAS BY THE DETECTION OF MICROFILARIAE IN SENTINEL MOSQUITO POPULATIONS. Gad, A.M., Farid, H. A., Soliman, B.A. and Morsy, Z.S. (Research & Training Center on Vectors of Diseases, Ain Shams University, Cairo, Egypt)

Conventional methods for diagnosis of bancroftian filariasis are usually hampered by the need for collection of night blood form human subjects to detect microfilariae (MF). The present study describes a simple screening test to locate filariasis endemic areas which based on the detection of MF in blood meals ingested by wild caught mosquitoes instead of human night blood. Data pertaining to experimental infection of Culex pipiens mosquitoes with Wuchereria bancrofti revealed that after 1 hr post infection 87% of the surviving MF were still present within the mosquito midgut and most (74%) of these MF were observed resting in the thoracic muscles, 12 hr post-infection. We have evaluated the performance of detecting MF in blood meals of mosquitoes collected from bedrooms within 1 hr post-feeding. MF were detected in mosquitoes collected by aspiration (at 10-11 PM) from 7 out of 44 (15. 9%) households sheltering microfilaremic individuals in a known filariasis endemic village. Screened blood-fed mosquitoes were Cx. pipiens, Cx. antennatus and Anopheles pharoensis with MF infection rates of 5. 2%, 0. 01% and 12.5% respectively. The same blood meal test was also applied to a nearby village with no previous records of filariasis prevalence. In that village, MF were detected in the blood meals of 0.9% Cx. pipiens and 0.3% Cx. antennatus collected in 64 households. We conclude that the use of freshly embibed blood meals to detect MF of W. bancrofti in sentinel mosquito population is reliable as a primary step to locate filariasis endemic foci. This screening technique should precede systematic epidemiological surveys in filariasis surveillance strategies.

THE DISSEMINATION AND DISTRIBUTION OF DENGUE VIRUS IN MOSQUITO AEDES ALBOPICTUS. Yanni Wang (Department of Parasitology, Zunyi Medical College, Zunyi, Guizhou 563003, China), Sheng Zhang, Guiming He (Department of Parasitology, Sun Yat-sen Universtiy of medical Science, Guangzhou 510089, China)

The dissemination and distrbution of Dengue 2 virus was studied in parenterally and orally infected Aedes albopictus using indirect immunofluorescent technique. Viral antigen was detected in cardiac junction, fat body, thoracic ganglia, salivary gland and brain after parenteral infection. It suggests the cardiac junction was susceptible to Dengue virus and might be one of the routes for dissemination extra-intestinally. The fat surrounding the brain, thoracic ganglia, midgut and other organs was redily infected. It might play a role of extension of infection to adjasent tissues and organs. The infection rate of brain being higher than that of salivary gland either in parenteral and oral infection suggests the presence of salivary gland infection barrier. After oral infection, the posterior portion of midgut was initially infected, then extended to the middle portion. No viral antigen was detected in the ovarian sheath, oviduct and follicles. It seems there was no evidence of transovarial transmission of Dengue virus in Aedes albopictus.

TREATMENT OF ECTOPARASITES BY IVERMECTIN (IVOMEC^R) IN CERVIDAE (RED DEER, ROE DEER). Kutzer Erich (Institute of Parasitology and General Zoology, University of Veterinary Medicine, A-1030 Vienna, Austria).

In a series of trials with Cervus elaphus hippelaphus (red deer) and Capreolus c. capreolus (roe deer) in game preserves and in hunting grounds the efficacy of the injection solution of ivermectin, Ivomec^R (-injection 1%). was tested in a peroral application. For that reason Ivomec^R was mixed with water in a ratio of 1:20-50 and sprayed by a syringe of trees on the daily proportion of concentrated feed. This medical feed was brought immediately afterwards to the feeding grounds and was taken on by game readily. Red deer and roe deer were treated with 2 x 200 mcg and 1 x 300 mcg ivermectin/kg body weight. This dosis was highly effective (up to 100 percent) against Pharyngomyia picta and Hypoderma actaeon in red deer and Cephenemyia stimulator in roe deer. Also Lipoptena cervi as well as the most important stomach-, intestine- and lung-nematodes were effectively controlled by this method of treatment. Side-effects could not be registered.

MYIASIS IN IRANIAN WILD GOAT, *CAPRA AEGAGRUS* (ARTIODACTYLA, BOVIDAE, CAPRINAE). M.J. Ghassemi (Iranian Research Organization for Science and Technology), S. Tirgari (Faculty of Hygien, Tehran University of Medical Sciences, IRAN)

The international advance notice of FAO to many countries, including IRAN, concerning the invasion of *Cochliomyia hominivorax* (screwworm) into LIBYA anticipated the study of myiasis among the wild life that are supposedly to be the most vulnerable target of that fly in case they were run off. The purpose of the study was to assess the extend of damage of indigenous flies that cause myiasis in our wild life before the invasion of the New World screwworm. In our study, we investigated myiasis primarily in wild goat and some other wild life such as wild pigs etc... in the provinces of Khuzestan, Boushehr, and Hormozgan, that are considered the gates of entry, eventually. The province of Hormozgan at the neck of Persian Gulf is the unic cross road of Palearctic, Oriental, and Ethiopian Regions. The dominant subcutaneous myiasis in wild goat caused by three species of flies belonging to the Genus *Przevalskiana* (Oestridae). They were *Pr. crossii, Pr. silenus, Pr. aegagri.* The following species were also found in the horn cavity and the sinus: *Oestrus ovis* and *Rhinoestrus tshernyshevi.*

FIELD EVALUATION OF THREE INSECT GROWTH REGULATORS ON FLIES IN POULTRY MANURE. Ibrahim k. Nazer (Faculty of Agriculture, University of Jordan, Amman, Jordan)

Manure is used on a large scale in the intensive agriculture area under irrigation in the Jordan Valley (JV). This style of agriculture provides unique conditions for housefly development. The insect has developed resistance to most insecticides (Abu Nada and Nazer 1990). Insect Growth Regulators (IGRs) with their unique mode of action provides new avenue for controlling this pest. Three IGRs (Diflubenzuron 25 wp, Methoprene 10 F, Pyriproxyfen 0.5C) with three application rates were tested for the control of the H. fly in poultry manure in the field. All treatments showed their larviciding effect after a week of the IGR application. The number of emerged adult H. flies in all treatments were much lower than the control. Differences between the different IGRs and concentrations are illustrated in five tables and six figures.

EXPERIMENTAL INFECTION OF FORCIPOMYIA (LASIOHELEA) TAIWANA WITH HEPATITIS B VIRUS. Nian-shan Liu (Department of Microbiology, Chongqing, Sichuan 630046, China) , Ming-fang Cao (Chongqing Railway Hospital, Chongqing sichuan 630053), Qi-ming Liu (Tianjin He-dong Health Care Station, Tianjin 30015, China)

Forcipomyia (Lasiohelea) taiwana was infected from a donor with a high titer of HBs Bg. Of the freshly killed midges 66.6% were found to have ingested hepatitis B virus. An infectivity rate of 17. 5% was observed in dead midges between the fifth to fifteenth days after feeding. And an infectivity rate of 55.5% was observed in first-stage and second-stage larvae.

Although the midges is not known to be a natural vector of hepatitis B, this species readily feeds on man as well as on animals and frequently comes indoors to feed, it might play a role as a potential vector of hepatitis B.

DISTRIBUTION OF NEOTROPICAL BLACKFLIES AND BIOGEOGRAPHICAL RELATIONSHIPS (Simuliidae). Sixto Coscarón (Facultad de Ciencias Naturales y Museo,1900 La Plata Argentina.)

Neotropical blackfly faune is known by 353 species included in 26 supra speciphic taxa. Through vicariance biogeography we made an approach of paleogeographic areas. Distribution analysis gave 16 endemism areas. By cladistic methodology of Gigantodax (68 spp), S. (Pternaspatha) (27 spp), S. (Inaequalium) (116 spp), S. (Psaroniocompsa) (14 spp), S. (Chirostilbia) (12 spp), S. (Ectemnaspis) (37 spp), S. (Hemicnetha) (20 spp) and interpolation of distribution with Wiley Vicariance Biogeography Method,was obtained a cladogram area. The cladogram shows basically two sister groups: an austral with 3 endemism areas and a tropical with 13. The last has two branches: one in correspondence with the Andine-Patagonic subregion and the sister group with the Guyana-brazilian plus Northern South America and Mesoamerica. Congruence between endemism areas and paleogeographic changes are explained.

THE IDENTITY OF A VL VECTOR ACROSS THE NORTH-WESTERN CHINA AND THE MIDDLE-ASIAN SSRs OF USSR - PHLEBOTOMUS SMIRMOVI PERFILIEW, 1941. Yan-jia Leng (Department of Medical Parasitology, Faculty of Medicine, Jinan University, Guangzhou 510632, China)

P. smirnovi has been a well known important vector of VL in the Middle-Asian SSRs near to China. Ting & Ho (1962) reported P. major in western Xinjiang, China. Yang & Xiong (1965) studied a sandfly from North and South Xinjiang and named it P. major wui and concluded that Ting & Ho's P. major was P. major wui. Artemiev & Neronov (1984) studied P. major wui from Mongolia and Western China and compared with P. smirnovi from USSR. They renamed it as P. wui stat. n.. Xiong & Jin (1987) renamed it again P. wui stat. n.. Leng, Lane & Jweis (1987) synontmized P. wui to P. smirnovi based on the morphology of the specimens from China and USSR (including syntypes).

Restudy of Chinese and Mongolian specimens: The author collected P. smirnovi in Ejina Banner, Inner Mongolia near to Sino-Mongolian boundary about 40 km from Chagan-bogto. Mongolia where artemiev & Neronov collected their specimens. After a careful study, campared with all former descriptions, no stable and significant differences were found which can be used as the characters for species identification. Under the concept of stereomorphology it is easily understand that the female pharyngeal atmature are really same. And unlike Artemiev &Neronov (1984) deduced that "P. wue" mainly distributed in the west instead of east of Junggar & Tarim Basins. The author affirms as he affirmed before that the "P. wui" is a synonym of P. smirnovi.

ENTOMOLOGICAL PROBLEMS IN LEISHMANIASIS IN INDIA. S.M. Kaul, (National Institute of Communicable Diseases, Delhi-54 India). P.G.S. Prabha, S.S. Sehgal (Zool Deptt., Univ.of Delhi, Delhi-7 India.)

Visceral Leishmaniasis or Kala-azar caused by Leishmania donovani and transmitted by sandfly, Phlebotomus argentipes occurs in North India in epidemic waves; a wave is still on in Bihar State. Present work comprises a review of work done in India since early 1920's on biology and control of Phlebotomine vectors, identifying the lacunae still existing in our understanding of the subject. The review is presented under four heads. (1) Spatial distribution and sampling of sandfly populations. (2) Sandfly bionomics. (3) Vector-parasite relationship and (4) control of vector. It has been aruged that evaluation of control programmes has never been undertaken satisfactorily as sampling techniques are not standardized. There is an urgent need of upgrading distribution records, generating information on larval bionomics, age-grading of vector population and transmission mechanism, which would ameliorate the assessment of vector control programme. Development of DDT resistance in P. papatasi and p. argentipes makes it imperative to generate data on the susceptibility status of vectors by standard WHO methods and newer techniques.

ASSESSMENT OF ZOONOTIC POTENTIALS OF CERTAIN ECTOPARASITES ON SOME DOMESTIC MAMMALS, M.K. Nayak and S.S. Sehgal (Department of Zoology, University of Delhi, Delhi 110 007 INDIA).

A survey of zoonoticaly important ectoparasites viz. ticks, lice and fleas was carried out in different domestic mammals of local breed, cows, buffaloes, goats, sheep, cats and dogs. The fleas, Ctenocephalides canis and C. felis were restricted only to dogs and cats, while the ticks (Boophilus microplus and Hyalomma anatolium) occured on a broad range of hosts. The cattle were extremely prone to the infestations of lice Bovicola bovis and Linogathus vituli, besides the ticks. The buffaloes however, seemed to be free from the infestations of all the ectoparasites except a louse, Haematopinus tubercalatus which was interestingly seen to restrict its infestation only to the buffaloes. The host-ectoparasite association as well as the ecological conditions under which these ectoparasites flourished on the host body were analyzed quantitatively by Specificity Index (S. I.) and rates of infestation and incidence. A complete list of reported cases (spreading over a three-year span) of ectoparasite-borne diseases in domestic mammals was recorded from the District Veterinary Hosptial in the area to appraise the zoonotic potentials of these electoparasites.

INTERPRETATION OF MATING BETWEEN TWO BEDBUG TAXA IN A ZONE OF SYMPATRY IN SOUTH AFRICA. R.H. Hunt, M. Coetzee, D. Walpole (Medical Entomology, SAIMR, Johannesburg, South Africa)

Two taxa of man-biting bedbugs, *Cimex lectularius* and *C. hemipterus*, have been considered separate species on the basis of morphological differences between them and because when *C. hemipterus* ♂♂ mate with *C. lectularius* ♀♀, the ♀♀ are rendered permanently sterile and may die. The reciprocal cross produces sterile eggs but subsequent mating with a compatible ♂ results in viable offspring. Studies show that *C. lectularius* ♀♀ and *C. hemipterus* ♂♂ mate readily in nature in northern KwaZulu, South Africa (69% N=16, 44% N=219) and, where *C. hemipterus* occurs in sufficient numbers, *C. lectularius* is rapidly eliminated. The reciprocal cross has been observed in the laboratory but its frequency in nature is unknown. These results are discussed with reference to two current species concepts, the Recognition Concept and the Isolation Concept, resulting in two opposing views of the bedbugs' evolutionary status. When applying the Recognition Concept, the frequent mating which occurs in nature between the two populations suggests that they share a common fertilization system and are, therefore, conspecific. The prediction, in accordance with population genetical theory, that natural selection will act to eliminate the cause of a disadvantaged gene or genome, appears to be correct, leading to the parapatric distribution of the two forms. In contrast, under the Isolation Concept, the two populations are clearly regarded as distinct biological species due to the existence of "post-mating isolating mechanisms".

SUBJECT : MEDICAL ENTOMOLOGY

TITLE : PTHIRIASIS PALPEBRARUM - by Pubic louse

AUTHORS : SHASHI BHALLA & NEERAJ K. VIJ

Pthiriasis palpebrarum is an infestation of the eyelashes and eye brows by the pubic louse (Pthirus pubis). An 19 year old male showed heavy powdering on the lashes of the upper and lower lids of both eyes. On detailed examination, adult lice were spotted on the left upper lid, firmly gripping the roots of eyelashes. External examination of the rest of the body didn't show any evidence of nits/Lice. For treatment 20% Flourescein was applied to the Lid margin and lashes and this was repeated after 10 days. A repeat examination of eyelashes/lid did not reveal any nits/parasite. Topical application of 20% Flourescein is the newst treatment regimen as it is easy to administer and is highly effective in the treatment of Pthiriasis palpebrarum.

BREEDING SOURCES OF ANOPHELINE MOSQUITOES IN TWO PHYSIOGRAPHICALLY DIFFERENT AREAS IN NORTH WEST RAJASTHAN, INDIA. B.K.TYAGI (Regional Medical Research Centre (Desert), I.C.R.M.,Post Box 122, New Pali Road, Jodhpur-342 005, India).

Of the seven anopheline species collected from district Ganganagar, northern Rajasthan, part of which is extensively irrigated through three major canal systems originating from Beas-Sutlej confluence and Bhakra feeder canal in Punjab State, three vector species, viz. Anopheles culicifacies, A. stephensi and A. subpictus have been studied for their breeding habits. A total of ten habitats were found positive for breeding by any species. While A. culicifacies preferred to breed in irrigation channels and flood waters, A. stephensi showed marked affinity to breeding in shallow earthen pits, locally called "TANKA", in desert areas as well as large lakes formed by flood waters in semi-arid areas after monsoon. A. subpictus bred profusely in post-monsoon pools and ditches. Breeding of A. stephensi in the desert areas located in the western part of the district has been discussed in detail.

BITING AND RESTING BEHAVIOR OF ANOPHELES CULICIFACIES IN GHASREGHAND, BALUCHISTAN, IRAN. M.Zaim, G. Mowlaii, K. Pakdad, A. V. Manouchehri, M. Motabar, Gh. Edrissian, H. Ladonni, M. Nazari (School of Public Health, P. O. Box 6446, Teheran 14155, IRAN).

Biting and resting bahavior of anopheline mosquitoes constitute important aspects of malaria epidemiology and control. Therefore studies were carried out in Ghasreghand, from May 1990 to March 1991, where malaria is a major health problem and An. culicifacies is regarded as the major vector. Outdoor human and animal (cattle) biting collections revealed human and cattle biting rates to range between 0 to 6 and 0 to 42, respectively. Anopheles culicifacies showed two peaks of biting activity, one in May and the other in September. Only 64% of the biting activity was found to occur before the midnight. Out of the total of 1083 blood smears of An. culicifacies captured by different sampling methods 4.9% reacted with human antiserum. The anthropophilic index was found related to the proportion of human and cattle population in an area. Although this species is regarded as endophilic, a good proportion of the population rested outdoors. Peak entrance and exit to and from human and animal dwellings, as assessed through installations of inlet and outlet window traps, was found in the 1st and 4th quarter of the night, with the last peak being more pronounced. A good deal of movement was noticed in An. culicifacies females during the night.

ECOLOGICAL HABITATS OF MOSQUITOES(CULICIDAE) IN MACAU Emmett R. Easton(Macau Polytechnic Institute,formerly University of East Asia, P.O. Box 3001, Macau)

Recent urbanization in Macau has seen a decline in swampy habitats that supported populations of Anopheline mosquitoes inthe past and there is no evidence of the current presence of Aedes aegypti. The fauna and flora of Macau have similarities with that of neighboring Hong Kong where some 70 species of mosquitoes have been reported.

At this time some 16 culicine species of mosquitoes have been reported in Macau which includes a peninsula connected with mainland China and the two islands of Taipa and Coloane. The most abundant species is Culex quinquefasciatus that can maintain itself in polluted fresh water. The second most abundant species is Aedes albopictus observed breeding on the islands in artificial containers used for collecting refuse and found along hillside forested trails on Taipa and Coloane. This species has also been found breeding in abandoned tires as well as road culverts. The predatory-larva of Toxorhynchitis splendens has been observed feeding on A. albopictus at sites where water accumulations persist. The pitcher plant leaves of Nepenthes mirabilis support populations of both Culex sumatranus and Armigeres magnus while rock pools by the sea on Coloane have been found inhabited by C. sitiens.

THE DYNAMIC SIMULATION OF CULEX QUINQUEFASCIATUS POPULATION. Beicheng Xia, Changqing Zhou, Haidong Chen (Research Institute of Entomology, Zhong-shan University Guangzhou 510275, China)

Some important processes of development and reproduction of Culex quinquefasciatus are approached numerically by taking the measure of system analysis, such as the rate of development, mortality, sex ratio, life-span of adults, number of eggs oviposited by a female, preoviposition period and gonotrophic cycle etc. These processes are influenced by environmental factors obviously. Temperature is the most important one of them, so we pay more attention to temperature. Basing on the relationship between a process and the environmental factors, a suitable mathematical model is built against every process. According to the logical sequence in biology these models of processes are coupled into a comprehensive model. We use the model to simulate the natural population of C. quinquefasciatus.Because of the difference from laboratory or semi-laboratory population to natural population and the interactions between processes, some parameters in submodels have been corrected. Through 5 year-times simulations, the results show the simulative populations and the natural populations are good identical in peak periods and peak values.

DRY SEASON SURVIVAL OF SOIL-BASED EGGS OF *AE. AEGYPTI* AND *AE. VITTATUS* IN SHALLOW AND DEEP ROCK POOLS IN JOS, NIGERIA. E.N. Inyang and R.J. Irving-Bell (Department of Biological Sciences, University of Calabar, Nigeria).

In Jos metropolis, *Aedes* mosquitoes disappear during the dry months of the year and reappear soon after the first rainfall. Relative survival studies of *Ae. aegypti* and *Ae. vittatus* were carried out in 3 rock pools (2 shallow Q,R; 1 deep, S). Percent hatch after 16 weeks exposure for *Ae. vittatus* were 25.1%, 5% and 7% for Q, R and S pools respectively. After 17 weeks, percent hatch fell to 1.4% for Q Pool. *Ae. aegypti* recorded 0% hatch for all the rock pools but survived a 44 days exposure in the laboratory under controlled temp. (27±1°C) and relative humidity of 75%. Soil temp. extremes of 16.1-48.9°C, 16.2-45.7°C, 15.0-45.0°C and 14.0-44.0°C were obtained for Q, R and S, respectively with 11.0°C-34°C atmospheric temp. and 03-82% atmospheric relative humidity extremes. Thus eggs of *Ae. vittatus* and to a lesser extent *Ae. aegypti* are able to survive periods of dessication in the field, probably due to lower night temperatures and the mitigating effects of the soil microhabitat.

STUDIES ON THE LARVAL POPULATION MODEL OF CULEX TRITAENIORHYNCHUS. Wei-dong Gu (Department of Parasitology,Second Military Medical University, Shanghai 200433,China) Bao-lin Lu (Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing 100850, China)

The laboratory larval population dynamic model of Culex tritaeniorhynchus Giles was set up using dynamic life table approach. Regression equations were formulated from which the abundances of various instars were estimated from dip sample in fields. Based on laboratory larval population model and consequtive sample data from a cohort of 1000 newly hatched larvae put in a rice pond, the survival rates and natural inhibiting rates of various instars were estimated by black box approach. The survival rates of the first,second,third,fourth instar and pupae were 85,75,69,80 and 75% respectively, and inhabiting rates were 18,46,11,30 and 28% respectively.The development rate of the laboratory larval population was 1.33 time faster than that in rice pond. The simulated results of the single generation of Cx. tritaeniorhynchus larva in rice pond were similar to the observed ones.

ECOLOGICAL STUDIES ON FIELD PREADULT POPULATION OF THE MOSQUITO:AEDES ALBOPICTUS.Peng Weidong(Dept.of Parasitology,Jiangxi Medical College,Nanchang330006, China)

Seasonal fluctuation of larva and pupa density was investigated from March of 1990 to January of 1991 on the campus of Jiangxi Medical College with bamboo section traps.Based on the data,the spatial distribution patterns of preadults were studied. The results suggest that mean population density influence distribution patterns and all aggregation indices used.The power b,from Taylor's model is not significantly different statistically between the individual instar and pupa and total preadults.It suggests that the power b seem to be a special character of the mosquito.The α and β from Iwao's model indicate that the basic components of the distribution patterns seem to be groups of several individuals, and that the contagiousness of these components of each stage of larva become less and less with the increase of instar.

The method of fuzzy cluster analysis was used to discuss population dynamics in both aspects of spatial distribution pattern and mean density.

FEASIBILITY OF USING PERMETHRIN TREATED BEDNETS IN REDUCING MAN-VECTOR CONTACT AND MALARIA TRANSMISSION,WITH SPECIAL REFERENCE TO THE MAIN RURAL VECTOR IN INDIA-ANOPHELES CULICIFACIES GILES. B.K.Tyagi (Regional Medical Research Centre (Desert),I.C.M.R.,P.B.122, New Pali Road, Jodhpur-342 005, India).

The role of permethrin impregnated bednets at the application rate of 0.5 g(ai) Sq.m., as against the bednets without any treatment, in abading indoor resting density of A. culicifacies and marginally reducing the incidence of malaria transmission was evaluated in three tribal villages of Orissa State, viz.Kenduguda, Deulaguda and Bondaguda, all highly endemic for P. falciparum malaria, with particular emphasis on cost-benefit assessment and community's acceptance to the methodology.When compared with the control villages, viz. Deulaguda (where untreated bednets were distributed) and Bondaguda (where no bednets were supplied at all), fewer malaria cases were reported during fortnightly surveillance in the village Kenduguda where insecticide impregnated bednets were supplied. Per-man hour density was also found considerably reduced in the village.Kenduguda for nearly six months. Bioassay revealed that treated bednets produced 100% mortality against A. culicifacies for about six months with both unwashed and those washed for 1-2 times, albeit extensive tear and wear by the villagers.

The methodology had been found quite effective in the difficult mountainous terrains where conventional measures failed.

ENZYME VARIATION AT THE ASPARTATE AMINOTRANSFERASE (AAT) LOCUS IN MEMBERS OF THE *Anopheles gambiae* GILES GROUP OF SPECIES (DIPTERA: CULICIDAE) IN AFRICA. Maureen Coetzee, Richard Hunt (Medical Entomology, SAIMR, Johannesburg, South Africa) L.E.O. Braack (Department of Nature Conservation, Skukuza, South Africa)

The enzyme system aspartate aminotransferase (AAT) is used in many laboratories for the identification of *Anopheles quadriannulatus*, the animal biting, non-malaria vector species of the *Anopheles gambiae* complex. Samples of *An. quadriannulatus* from South Africa and *An. gambiae s.s.* from the island of Grand Comoros and the People's Republic of Congo, have shown variation of the electromorph frequencies which indicates that AAT has five alleles, the three slowest being found in *An. quadriannulatus* and the three fastest in *An. gambiae*, *An. arabiensis* and *An. merus*. Had electrophoresis been the sole method of identification, one *An. gambiae* from the Congo would have been misidentified as *An. quadriannulatus* having a 95/95 AAT mobility. Two *An. gambiae* from Grand Comoros, five from the Congo and one *An. quadriannulatus* from South Africa were unidentifiable, having AAT mobilities of 100/95. This overlap at the 95 allele suggests that the AAT system be used with caution when identifying members of the *An. gambiae* complex in malaria control programmes. Evidence is presented that indicates lack of gene flow between subpopulations of *An. quadriannulatus* in close geographic proximity in the Shingwedzi area, South Africa.

CONTROL OF DENGUE VECTORS USING GROUND-BASED ULV SPACE TREATMENTS OF LAMBDA-CYHALOTHRIN

Lim, J.L. and Lee K.F ICI Public Health Research Centre, Lock Bag no 1006, 75990 Malacca, Malaysia.

Aedes aegypti and ***Ae.albopictus*** are two important vectors of dengue and dengue haemorrhagic fever. Space treatment with insecticides can reduce vector densities and break disease transmission cycle. A new pyrethroid insecticide, lambda-cyhalothrin (WHOPES code no. 3021) was evaluated as ULV cold aerosols in comparison with cypermethrin against ***Ae.albopictus*** (susceptible strain) and ***Ae.aegypti*** (dieldrin resistant strain). Results revealed that lambda-cyhalothrin was highly effective at very low rates. The LC90 of lambda-cyhalothrin at 25m logging distance was 0.17 gai/ha against ***Ae.albopictus*** and 0.72 gai/ha against ***Ae.aegypti***, which was remarkably impressive in view of its resistance to dieldrin. Against the 2 vectors, lambda-cyhalothrin was 3-5 times more adulticidal than cypermethrin. Lambda-cyhalothrin also showed equally good adulticidal effect when diluted in oil or water. Lambda-cyhalothrin at 0.25 and 1 gai/ha was also effective against ***Anopheles maculatus*** and ***Culex quinquefasciatus*** respectively.

ESTABLISHMENT OF A CELL LINE FROM OVARIAN TISSUE OF *ANOPHELES SINENSIS* AND ITS CHARACTERIZATION
Lan Mingyang; Zhao Yuguang; Shen Baoxiang; Zhou Huayun & Fang Hongyuan (Jiangsu Institute of Parasitic Diseases, Wuxi, Jiangsu 214064, China)

A continuous cell line established from ovarian tissue of the mosquito *Anopheles sinensis* (Wuxi strain).The culture was initiated from individual disected ovary. The medium was TC 199, supplemented with 0.4% lactabumin hydrolysate (LH), 15% FBS as well as non-essential amino acids. The medium DMEM were also suitable for the cell growth. 20 days after initiation, the attached cells gradually formed a monolayer.The subculture was made by a 3-6 split every week by using trypsin, and 25 subculture have been passed. Some cells were stored in liquid nitrogen and successfully resuscitated. The primary cells were epitherial type, but with the subculture, some cells became longer in shape and developed to fibroblast type. Observation with TEM showed no contamination of virus or mycoplasma. There were relatively large amount of polyrebosomes in the plasma.The histochemical staining showed the extensive existance of PAS positive substance, NANE, AKP, ACP,and about 1% of the cells existed CHE. The chromosome number was 2n=6. The species-specific DNA probe of this kind of the mosquito could be well hybridized with the mosquito cell DNA.

POTENTIAL OF COMPOSITE REPELLENTS FOR PERSONAL PROTECTION AGAINST MOSQUITOES.
Raj K. Gupta, Dept. of Entomology, Walter Reed Army Institute of Research, Washington D.C. 20307-5100, USA

Personal protection is an inexpensive and practical means of reducing the biting activity of hematophagous arthropods and for the prevention of arthropod-borne diseases. Three candidate insect repellents are being considered for developing a broad spectrum long-lasting repellent formulation.

The in-vitro blood-feeding test method results indicate that CIC-4 (a lactone) had greater repellency against *Aedes aegypti* than deet, whereas it provided similar protection as deet against *Anopheles stephensi* and *Culex quinquefasciatus*. Data of composite repellent formulations under investigation for their synergistic or antagonistic effects will be presented and compared with other insect species.

THE RESPONSE OF CHLOROQUINE-RESISTANT PLASMODIUM FALCIPARUM TO SULFADOXINE-PYRIMETHAMINE IN THE MALARIOUS AREAS OF IRAN.

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School of Public Health and Institute of Public Helath Research, Teheran University of Medical Sciences,Iran.

Malaria is endemic in the south-eastern parts of Iran. Chloroquine-resistant P.falciparum cases have been found in these areas since 1983.The response of the cases of chloroquine - resistant P.falciparum have been assessed to sulfadoxine-pyrimethamine(Fansidar,manufactured by SPIC in China) by the in vivo susceptibility test in Iran-Shahr and Bandar-Abbas Field Research Stations(Sistan-Baluchestan and Hormozgan Provinces).The 7- day standard field test was carried out and whenever possible the test was extended up to the end of the week 5.

Altogether,from 69 chloroquine resistant P.falciparum cases tested during 1990-1991,11 cases(15.9%) showed resistance to Fansidar at RI(7 cases),RII(3 cases) and RIII(1 case) levels. 7 cases were RI or probably reinfection,29 cases were sensitive and 22 cases were either sensitive or resistant at RI level.

SUSCEPTIBILITY OF THIRTY SPECIES OF MOSQUITOES TO ROMANOMERMIS YUNANENSIS. Yufang Peng (Department of Parasitology, West China University of Medical Sciences, Chengdu 610041, China)

A New species of Mermithidae was found parasitizing the larvae of Culex tritaeniorhynchus and Culex fatigans in Henan, China and then named Romanomermis yunanensis (Song & Peng, 1987).

Thirty species of Mosquitoes involving six genera have been tested for susceptibility to R. yunanensis and culicine mosquito have consistently been highly susceptible. At a 1:5 ratio of mosquito larvae to nematode juvenilis, the parasitism of Aedes aegypti, Ae. albopictus, Culex fatigans, Culex tritaeniorhynchus, Anopheles sinensis, Psorophora columbiae and Culesta inornata was 98.2%, 98.5%, 98.6%, 97.1%, 0%, and 99. 0% respectively. R. yunanensis presented a phenomenon of retarted develpoment in Anopheles maculatus, which remained at the parasitic stage both in the larvae and pupa of An. maculatus. The parasitism of dirus was 89. 7%, but most (88. 8%) parasitizing mermithids underwent melanization and died.

The comparative susceptibility of some North American mosquitoes to R. yunanensis and R. culicivorax at a 1:5 infectivity ratio. Both percentage infection and intensity of infection statistic support the generalization that, under laboratory conditions, R. yunanensis is a more vigorous and aggresive parasite of culicines.

THE ISOLATED ENTOMOPATHOGENIC BACTERIA FROM AYUTTHAYA PROVINCE, THAILAND, POSSESSING TOXICITY AGAINST MOSQUITO LARVAE.
L. Chowanadisai, S. Thanasripukdikul, S. Ramsiri (Department of Medical Sciences, Tiwanon Road, Nonthaburi 11000, Thailand)

The search for entomopathogenic bacteria against mosquito larvae is a part of the activity on a survey and development of local strains of bacteria for mosquito control. At the early phase, sample of soil and water from the water resources of 6 provinces in the central region of Thailand were collected. Isolation of the spore-formimg bacteria and screening of human pathogenic bacteria have been made. Toxicity tests of unidentified as well as non-pathogenic isolates toward aedinine and culicine larvae were performed. According to the criteria, only 2 isolates collected from Ayutthaya province were recorded. Both isolates were identified as Bacillus sphaericus in H-5 serotype. They were completely larvicidal to Cx. quinquefasciatus particularly the strain Ayutthaya #7 which provided LC_{50} at the concentration almost be equal to those of the reference strain, B. sphaericus 2362. Result from preliminary observation on the effect of the isolated strains against the predaceous larvae, Toxorhynchites splendens revealed that they did not kill the tested species.

Feeding strategies of mosquito larvae and the evolution of head capsule morphology in Diptera, Nematocera

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Behavioural video studies and experiments on feeding larvae of Culicinae and Anophilinae have shown that behaviour and head capsule morphology are linked in a dynamic, functional system. Different feeding modes are described and especially that of suspension feeding Culicinae is analyzed. The head morphology has different functional subsystems, which are cooperating to create a flow pattern around the larvae. With the help of that, particles are accumulated at the front of the head. The morphological subsystems are partly based on rigid structures, partly on flexible and membraneous areas. Both form an energy saving apparatus for continuous feeding. Comparison with other aquatic and terrestrial nematoceran larval head capsules are made. Several evolutionary trends in the architecture of the feeding apparatus of nematoceran larvae of ectoparasitic significance are defined.The evolutionary direction of the lines these trends form is discussed.

MORPHOMETRIC VARIABILITY IN THE LARVAE OF CULEX QUINQUEFASCIATUS SAY FROM BANCROFTIAN FILARIASIS ENDEMIC AND NON-ENDEMIC AREAS P.G.S. Prabha, S.S. Sehgal (Department of Zoology, University, of Delhi, Delhi 110 007 (INDIA) S.M. Kaul (NICD, Delhi - 54. India).

Larvae of Culex quinquefasciatus were collected from various wild rural habitats of two filariasis-endemic areas-Varanasi and Kerala (these localities are far apart) and a non-endemic area around Delhi. Seven morphometric characters -- dimensions of heads, antennae, pecten teeth, comb scales, siphon tube, siphon tuft and saddle, were compared for their variability. Siphon tuft, siphon index and saddle index showed a significant degree of variability in the two types of populations from endemic and non-endemic areas. These traits therefore, appeared to be of high taxonomic reliability. The variability in other traits showed a stability of these features in the non-endemic population as compared with those from endemic area. The progression of variability from most stable to most variable characters and the correlation of the variability of certain traits with the role of microhabitat and population fitness are discussed in the paper.

LETHAL EFFECTS OF THE ARMATURES OF MOSQUITOES ON MICROFILARIAE OF BRUGIA MALAYI. Shen-yi He,. (Department of Parasitology, Shandong Medical University, Jinan 250012, China)

The armatures of Anopheles sinensis, Aedes togoi and Culex pipiens pallens as well as their lethal effects on the ingested microfilariae of periodic Brugia malayi were studied in the present experiment. A. sinensis and Ae. togoi only have pharyngeal armature, this armature consists of a group of strong spines and killed 8-13% of ingested microfilariae respectively. C.p. pallens, a refractory vector for B. malayi, has poorly developed pharyngo-cibarial armatures which killed 7% of ingested microfilariae. After staining the damaged microfilariae revealed nicks in the sheaths, holes in the cuticles with exuding internal contents. The in vitro cultivation of mosquito mid-guts showed that microfilariae injured by the mosquito armatures were unable to penetrate the gut wall while those survived from being damaged by the armatures had the opportunity to penetrate the gut wall and finally developed to the mature infective stage larvae in the thoracic muscles.

BIOSYSTEMATICAL STUDIES ON CULEX PIPIENS COMPLEX IN CHINA (DIPTERA: CULICIDAE). Tong-yan Zhao, Bao-lin Lu(Institute of Microbiology and Epidemiology, Beijing, 100071, China)

There are four species or subspecies generally considered to be members in Culex pipiens Complex, namely, Cx.p.pipiens, Cx.p. pallens, Cx. p. quinquefasciatusor Cx. quinquefasciatus named by most of western workers, and Cx. p. molestus. The first three have been recorded in China. Although a lot of studies have been devoted to this Complex, controversies and confusions regarding to the species rank and relationships between the members are still remained to be solved. The present paper is the results of biosystematical studies including hybridization, mathematical analysis of morphological characteristics of both adults and larvae, particularly of different geographical strains and gybrids F1, GC analysis of culticular hydrocarbons, fatty acids and monosaccharides, and electrophoresis of egg proteins. On their allopatric destribution, it could be concluded that Cx. pipiens Complex in China is consisted of three subspecies, i.e., Cx. p.pipiens Cx. p. pallens and Cx. p. quinquefasciatus. The last one can not be considered as a separated species, and Cx. p. pallens is not an "intermediate" either as claimed by some western workers.

STUDIES ON THE SPECIES COMPLEX OF Anopheles minimus Theobald (Diptera:Culicidae) IN VIETNAM.

Truong Quang Hoc,Trinh Dinh Dat and Ngo Giang Lien
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Studies on the An.minimus complex from the genetic view point were carried out from 1988 to 199I in Northern Vietnam.Preliminary results showed that there is a polymorphysm in morphology,sex chromosome and isozyme systems in 7 studied populations of An. minimus complex.Most of the observed morphological variations are intraspecific.There are at least two species in An.minimus complex in Vietnam which have certain differences from those described by other authors from China and Thailand.They can be easily distingushed by sex chromosome and isozyme systems ODH and MPI...Due to the wide morphological variations for identification of An.minimus,it is necessary to consider and combine the different characters

Study on the genetic nature of morphological variations of Anopheles minimus Theobald in Vietnam

Ta Toan, Hoang kim Phuc, Do le Thang.
Faculty of Biology, University of Hanoi, Viet nam.

Wild mosquitoes of An.minimus collected from 10 different localities were morphologically grouped. Their offspring were selected for the homozygotes of A-, B-, C- and D- forms based on the costa base. The results of genetic analyses showed that the A- and B- traits belong to the quantitative ones and might be genetically controlled by two loci. Temperature is either a modificative or mutagenic or selective agent reducing the proportion of A- mosquitoes with fitness and reproductive activity depressed in cold season, but for the B- mosquitoes in hot season. The A- genotypes have adapted and prevailed in Summer and in Southern part of minimus fauna, they can group in a "Summer" gene pool/ecotype or tropical race. But the B- genotypes have adapted and prevailed in Winter and in Northern part of minimus fauna, they can group in a "Winter" gene pool/ecotype or temperate race. The C- and D- forms perhaps are closely relative to the B- form more than the A- one.

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GENETIC STUDY OF MALATHION RESISTANCE IN ANOPHELES STEPHENSI LISTON - A MALARIA VECTOR

N.J.Shetty and Gangadhar Rao (Centre for Applied Genetics, Bangalore University, Bangalore - 560 056, INDIA)

An.stephensi belongs to the order 'Diptera' and sub-genus 'Cellia'. It is an important urban malaria vector in the Indian sub-continent. The present paper deals with genetic basis of malathion resistance. In order to establish the genetic basis of malathion resistance, reciprocal crosses were made between the homozygous stocks for malathion resistance and susceptibility. A part of the F_1 were backcrossed to the parental type. The remaining mosquitoes were inbreed to get F_2 generations. The X^2 values were calculated for the various genetic crosses. The data on the mechanism of malathion resistance in An.stephensi clearly showed that the gene 'MR' is incompletely dominant.

THE RESPONSE OF Anopheles arabiensis TO HOUSE SPRAYING OF DDT AND LAMBDACYHALOTHRIN

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Anopheles arabiensis is one of the major vectors of malaria in Tanzania. However, this species has been shown to be heterogeneous in respect to its biting and resting behaviour.

In evaluating the response of this species to house spraying of DDT and lambdacyhalothrin, mosquitoes were collected fortnightly for determinations of sporozoites, parity, chromosome inversions, resting behaviour and source of blood meals. Malaria in children was assessed by taking temperatures, and blood slides and by measuring levels of anti-sporozoite antibodies.

Contrary to the general expectation, mosquito densities, sporozoite and parity rates were significantly reduced. Similarly, the prevalence of fever and parasitaemia were reduced. However, the prevalence of anti-sporozoite antibodies was not reduced and did not show any association with reported clinical episodes or with episodes of high parasitaemia.

BIOCHEMICAL MECHANISMS OF DELTAMETHRIN-RESISTANCE IN MOSQUITOES. M.K.K. Pillai (Department of Zoology, University of Delhi, Delhi - 110 007, India).

Mosquitoes endowed with remarkable genetic adaptability have the ability to rapidly develop resistance to insecticides. Studies on the speed of selection for resistance to deltamethrin by the larvae and adults of Aedes aegypti, Culex quinquefasciatus and Anopheles stephensi for 40 generations showed high level of resistance to deltamethrin imparting high cross-resistance to DDT in the larvae of Culex but in Aedes resistance was confined to deltamethrin only. Precipitation of deltamethrin-resistance was very slow in Anopheles as compared to the other two species. A strong involvement of kdr gene manifesting both deltamethrin and DDT-resistance was evident only in Culex. However, deltamethrin-resistance in all the species showed significant correlation to mono-oxygenase activity, and selections with piperonyl butoxide along with deltamethrin drastically reduced the speed of development of deltamethrin-resistance in the larvae. In addition, the larvae of Culex showed enhanced estrase activity, thus indicating that in Culex deltamethrin-resistance was depended on mono-oxygenases, estrase and kdr factor while in other two species it was solely due to mono-oxygenases.

#1

The characteristics of the common form of Anopheles minimus Theobald in Vietnam

Ta Toan, Truong quang Hoc, Trinh dinh Dat, Pham van Lap.
Faculty of Biology, University of Hanoi, Viet nam.

The surveys of An.minimus from 15 locations during 1990-1991 proved that the common form had proboscis entirely dark (71.2%), palpus short apical dark band (52.1%), costa with presector pale spot (65.4%), L_3 two dark spots (94.1%), $L_{4.1}$ entirely dark (84.6%), $L_{5.1}$ three dark spots (85.6%), L_6 two dark spots (95.1%). Its frequencies of allele $Odh^{100} = 0.842 \rightarrow 1.000$; $Mpi^{100} = 0.306 \rightarrow 0.714$; $Aat^{100} = 0.854 \rightarrow 0.878$. Its karyotype composed of 3 chromosome pairs. Autosome 2 is the longest, submetacentice, two C-bands near centromer (a bigger band on short arm and a smaller one on long arm). Autosome 3 is metacentric and two equal bands on either side of centromer. Sex chromosomes are the shortest and heteromorphic. X is submetacentric, fork shape with branched pale short arm, two dark bands on long arm. Y is subtelocentric, heavily stainted on short arm and a long arm like that of X. Besides we have found many variations in morphology, isozymes and chromosomes of An.minimus in Vietnam.

This work belongs to ID890418 and VH3c projects supported by TDR/WHO and NUFFIC/Netherlands

#2

PRELIMINARY STUDIES ON THE EVOLUTION OF MOSQUITOES(DIPTERA:CULICIDAE).

Feng-yi Qu, Guo-zheng Qian (Department of parasitology, Second Military Medical University, Shanghai 200433, China)

A numerical phylogenetic analysis based on morphology, habit,and faunistic distribution of the world known mosquitoes of 38 genera including 3357 species/subspecies were carried out to study mosquito evolution. The phylogenetic relationship analysis among 8 families allied to Culicidae shows that Chironomidae is the most primitive archetype, whereas Culicidae is the earlist specialized higher group. The similarity and expansion routes of the common and unique genus from 6 zoo-geographical regions gives the similar images. The Neotropical is the place of source: Australian, Ethiopian, and Oriental are the intermediate: Nearctic and Palearctic are the terminal of the expansion. The continental drift, violent climate changes, and other environmental factors have impact on natural seletions and affect the modern mosquito faunistic distribution pattern. The figures of the faunistic distribution and evolution, and the Wagner tree of 38 genera of culicid mosquitoes give newly basic data and evolutionary informations for recompositfon of the taxonomic system of Culicidae.

#3

FAUNAL DISTRIBUTION OF MOSQUITOES OF CHINA.

Han-bin Chen(Guiyang Medical College,Guiyang,Guizhou 550004,China)

According to the mosquito lists of China and the mosquito specimens examined, a estimate that there are 357 species of mosquitoes belonging to 17 genera, 3 subfamilies in China was made. Among these mosquitoes, 275 species are Oriental, whereas 67 are Palearctic, and the rest are cosmopolitan or interregional species. The Oriental elements are much more predominant than the Palearctic ones. The mosquito fauna in China can be divided into 3 subregions and 7 districts: North-Eastern district (with 66 species) and Northern China district (44) belonging to Manchurian subregion; Mongolian-Xinjiang district (42) and Qinghai-Tibetan Plateau district (21) belonging to Centro-Asian subregion of Palearctic region; Central China district (124), South-Western China district (93) and Southern China district (257) belonging to Indo-China subregion of Oriental region. On the other hand, the fauna shows a district endemic character, since 63 species (about 18%) are so far limited only to China. On the basis of the Zoogeographical divisions of Chinese mosquitoes, especially Culex pipiens complex, the author suggests an emendation of the border line between the Palearctic and Oriental region in China.

#4

PRELIMINARY STUDY ON THE GEOGRAPHICAL DISTRIBUTION OF *CULEX PIPIENS* COMPLEX IN SHAANXI PROVINCE.

Yi Weng, Xiao-lin Lu, Zhong-xiang Liu (Department of Parasitology, Fourth Military Medical College, Xian 710032, China)

Both *Culex pipiens pallens* and *C. quinguafasciatus* of *C. pipiens* complex are important vector of the diseases agents. Some researchers suggest that their delimitation of geographical distribution be about on 30 ° ~ 32 ° N., where the intermediate type of *C. mosquito* exists. Qin-ling mountain chains (30 ° ~34 ° N.) are considered as the natural delimitation between Palacatchic Region and Oriental Region, so the study on geographical distribution of *C. pipiens* complex here has special significance. The shape of male sex exterior paramera is an important evidence in morphological classification. We set up seven the investigate sections from Han-zhong to Yu-he (33 ° 05′ N.~ 38 ° 05′ N.) to collect specimens and dissect the male exterior paramera of 58 specimens. We not only observed there were three types of dorsal arm (cornu) end:"flat", "tongue" and "sharp", which belong to *C. pipiens pallens*, the intermediate and *C. quinguafasciatus*, respectively, but also found there are two types of the gradient variant specimens, which the shape of dorsal arm end are located between "flat" and "tongue" or between "tongue" and "sharp", so are named as "near *C. pipiens pallens*" and "near *C. quinguafasciatus*", respectively. Three of intermediate types locate on 33 ° 05N.′ ~ 37 ° 35′ N. (Han-zhong to Sui-de). In addition, the typical *C. quinguafsciatus* was discovered at 36 ° 30′ N. (Nan Ni-wan). This paper preliminarily suggests that the delimitation line of geographical distribution of *C. mosquito* shall be moved 5 ° to the North in China, which has an important valuc for the study on geographical distribution of *C. mosquito* and epidemiology.

#5

STUDIES ON DISTRIBUTION AND BEHAVIOR OF ANOPHELES MINIMUS AND ITS ROLE OF MALARIA TRANSMISSION IN HAINAN PROVINCE AT PRESENT

Wu Kaichen, Deng Da et al.
(Institute of Parasitic Diseases, CAPM,Shanghai 200025, China)

Anopheles minimus was a main malaria vector in Hainan Island and had been eliminated through the campaign of indoor residual spraying launched in 1959. It again became a incriminated vector of some focal malaria outbreak in recent years. The present study was conducted in a typical hilly area -Feibar in west part of Danxian county in 1989-90.

There were 50% and 62.5% of surveyed sites found A. minimus in mountainous area and hilly area of Danxian county respectively, and not found in coastal plain. A. minimus were found in all 18 sites surveyed in Feibar district, with 52% of anopheline composition. Man-biting rate made by human-baited collection was 3.2 before midnight and 38.2 when collected through whole night in some sites. A. dirus was not found in all sites surveyed. However, the behaviour characteristics of A. minimus have been changed as a species with exophilic, exophagic and equal preference to man and cattle. The vectorial capacity of A. minimus estimated by quantitatively data was in accord with malaria infection rate in Feibar district , and the malaria infection rate among the inhabitants are varied in three types of residential quarter with different socioeconomic conditions. Malaria infection rates of residential quarter of outcomers' reclamation, peasant village and state farm are 10%, 2.9% and 0.5% respectively during 40 days in July to August, 1990.

Owing to A. minimus being a secondary vector only next to A. dirus, with a wide range of distribution and a considerable different characteristics in behaviour compared to before spraying campaign , it is suggested that a malaria control programme must be seriously planed adjusting to the new problem of malaria epidemiology in Hainan province.

#6

SURVEY FOR CONTROL OF THE PESTS OF PUBLIC HEALTH IN CHINA.

Sheng-guo He (National Patriotic Health Campaign Committee, Beijing 100725, China)

Comprehensive control measures are promoted in China. Based on the understanding of the ecology of the pests, the environmental control are put at the first place, supplemented by other control techinques. The Office of National Patriotic Health Campaign Committee (ONPHCC) is the leading organization. The Supervise Department under ONPHCC is in charge of formulating and issuing policies, laws regulations and plans of long and short term about the control of the pests of public health. The Patriotic Health Campaign Committee for each province is in charge of carrying out the above duties. The Society of the Vector Biology and Control under ONPHCC is divided into different groups for eliminating fly, mosquito, bedbug, cockroach, and making equipment of killing pests. They are individually responsible to the consulation and guiding on the research and practice of control of the pests. According to the preliminary investigation, the major pests of public health in China are mosquito(more than 10 species) . fly(about 10 species), bedbug(2 species) and cockroach(16 indoor species) . Environmental, physical, chemical and biological control measures are the major methods of pests control. Environmental and chemical measures are emphasized.

#7
STATUS OF SWEDISH *CULEX PIPIENS* IN THE *CULEX PIPIENS* COMPLEX.
Takashi Ishii (Biology, College of General Education, Univ. of Tokushima, 1-1 Minamijosanjima, Tokushima, 770 Japan)

The SL strain of *Cx. p. pipiens* L., originally collected in Uppsala, Sweden in 1988 and having been maintained in the laboratory since then, is only one of the reported successful cases of laboratory colonization of populations derived from its northernmost distribution. Its northern strains, that are generally believed to be eurygamous, ornithophilic, and of the photoperiodical long-day type, are very hard to colonize under artificial conditions.

The stem of the SL strain has been maintained for more than 20 generations in a cage (30×30×30 cm) under laboratory conditions of 16.5 h-light, 5.5 h-dimlight and 2 h-dark photoperiod (LDimD 16.5:5.5:2), 22±0.5°C, and 90% RH, fed on Japanese Common Quail (*Coturnix coturnix japonica*). From the stem, a stenogamous strain that can be kept in a smaller cage (20×20×20 cm) and a short-day (LD 16:8) type have been selected and maintained for more than 10 generations. A mouse-feeder progeny failed to survive at the 5th generation. Comparisons in other biological characteristics will be made between the SL strain and counterparts from elsewhere the world.

#8
STUDIES ON CHROMOSOMES OF THIRTEEN SPECIES OF ANOPHELINE MOSQUITOES IN CHINA. Shu-bi Xu, Feng-yi Qu (Department of Parasitology, Second Military Medical University, Shanghai 200433, China)

Karyotypes of chromosomes in mitosis and the heterochromatin band of thirteen species of Anopheles in China were observed. They are maculatus, dirus, kochi splendidus, minimus, barbirostris, messeae, crawfordi, kunmingensis, kweiyangensis, hyrcanus, sinensis, anthropophagus. The results show that there are following three patterns of mitotic chromosomes which are useful in mosquito identification: 1. Y chromosome's centrimeric types and relative length of short arm; 2. Relative length of X chromosome's short arm and heterochromatin differences in quantity and distribution; 3. Heterochromatin differences in quantity and distribution of autosomes. The authors believe that An. maculatus and An. dirus are sibling species complex respectively in China because of their differences in chromosomes. The salivary gland polytene chromosomes of five anopheline species were also studied, which are hyrcanus, anthropophagus, sinensis, messeae, dirus. Extensive interspecific and intraspecific paracentric inversions are found and discussed.

#9
POLYTENE CHROMOSOME ARM NOMENCLATURE: A LOGICAL SYSTEM FOR USE IN ANOPHELINE GENETICS AND PHYLOGENY. R.H. Hunt (Medical Entomology, SAIMR, Johannesburg, South Africa) C.A. Green (120 Penistone Rd, Huddersfield HD5 8RN, England), M. Coetzee (Medical Entomology, SAIMR, Johannesburg, South Africa)

Historically anopheline mosquito polytene chromosomes have been named as the X chromosome and the "right" and "left" arms of the "second" and "third" chromosomes which obscures genetic homologies between arms of different species. For example, arm 2L of *Anopheles stephensi* is homologous with 3L of *Anopheles gambiae* and 3L of *An. stephensi* homologous with 2L of *An. gambiae*. Thus, if *An. stephensi* is used as the standard (2R+2L, 3R+3L), *An. gambiae* must have the configuration 2R+3L and 3R+2L, with the result that use of linkage groups, or chromosomes, 2 and 3 becomes illogical. A system has been devised whereby each autosomal chromosome arm is assigned a number (2, 3, 4 or 5). It uses *An. gambiae* as arbitrary standard for designation of homologous arms so that 2R+2L becomes 2+3 and 3R+3L, 4+5. Thus *An. stephensi* has a chromosome constitution of 2+5, 3+4. There is no need to refer to linkage groups in any further way. The system was chosen deliberately to emphasize the gross evolutionary genetics of the anopheline genome and provide a simple system for a single scheme of inversion notations throughout the subgenus *Cellia*. Modern genetic techniques will use phylogeny and also require the more logical system when DNA probes are tested and homologies established for DNA sequences between phylogenetically distant malaria vectors.

#10
STUDY ON MITOTIC KARYOTYPES OF THE SPECIES COMPLEX OF *ANOPHELES MINIMUS* THEOBALD (DIPTERA:CULICIDAE) IN VIETNAM.
Ngo Giang Lien, Truong Quang Hoc, Trinh Dinh Dat, Faculty of Biology, University of Hanoi, Hanoi, Vietnam.

Cytological studies on karyotypes of *An. minimus* the main malaria vector in Vietnam, we have shown some significant differences in the sex chromosomes.

The samples were collected from 7 different geographical areas and reared under laboratory conditions for studies in three aspects: morphological observation, cyto-taxonomy and electrophoretic analyses.

Mitotic chromosome preparations were made from brain tissue of fourth stage F1 larvae from an isofemale line using the Giemsa,G-banded technique described by Baimai *et al.* (1984) with slight modifications.

Interspecific and intraspecific variations were examined by means of the size as well as the banding patterns on the long and short arms of the sex chromosomes of *An. minimus*.

#11
STUDY ON THE PRESENCE OF PROPOXUR RESISTANCE GENES IN ANOPHELES STEPHENSI LISTON IN MINAB COUNTY SOUTHERN ISLAMIC REPUBLIC OF IRAN. H. Edalat, A. V. Manouchehri, M. Zaim (TEHERAN UNIVERSITY, SCHOOL OF PUBLIC HEALTH, P.O.BOX 6446-14155, TEHERAN, IRAN)

Anopheles stephensi liston is the main malaria vector in the southern part of Islamic Republic of Iran. This species is resistant to DDT, dieldrin, malathion.

Susceptibility tests carried out on wild caught An. stephensi, in Minab area, Hormozgan province (Formerly Bandar Abbas Province) showed that this species is still susceptible to propoxur. In order to forecast the possibility of existance of gene or genes of propoxur resistance in An. stephensi, 150 females of this species were transferred from Tomgohar village, Minab shahrestan, to our lab at the school of public health, Tehran university. The females of this species were put under the propoxur for 15 generations. This study showed that the LT_{50} of An. stephensi, has increased 2. 05 times that of its original value after 15 times of expossure in 18 months.

When the females of F_{15} were crossed to the susceptible males of this species it was shown that the resistance gene is semi - recessive. The susceptible colony had never been exposed to carbamates or organophosphorus insecticides.

Crossing the females of F_1 and the males of susceptible strain of An. stephensi, showed that single gene is responsible for resistance in An. stephensi.

#12
STUDY ON THE REPRODUCTIVE DIAPAUSE AND NEUROENDOCRINE REGULATION IN CULEX PIPIENS PALLENS. Jia-long Lu, En-ying Zhang, Ren-lai Wang (Department of Parasitology, Shanghai Second Medical University, Shanghai 200025, China)

Reproductive diapause of Culex pipiens pallens, which presents physiologically by ovary diapausing, refusing to suck blood and fat accumulating etc., may be induced by short-photoperiod at an appropriate temperature. In diapause mosquitoes, ovarian diapause is the major character, and is regulated by neuroendocrine system. The primary follicles cannot grow further, stop at N stage when adults are decapitated as soon as emergence just happens in both diapause and reproductive mosquitoes, and the primary follicles begin to develop about 24 hours after being decapitated in 5-day diapause adults. The corpora allata(CA) of diapause mosquitoes, by histologically examined, is characterized by small size, little cytoplasm, no vaculo and inactivity, so there is no phenomenon of synthesizing and secreting juvenile hormone(JH). The primary follicles of diapause ovary can develop when they were transplated into the abdomen of reproductive mosquitoes, and they fail to grow in diapause mosquitoes. JHA(ZR 515) and JH extracted from haemolymph of reproductive mosquitoes can make diapause follicles to grow. So diapause ovary is regulated by neuroendocrine system, and is related with absence of JH in haemolymph because of brain inhibiting CA from synthesizing and secreting JH in diapause mosquitoes.

#13

LABORATORY OBSERVATON ON THE GONOTROPHIC CYCLE OF CULEX PIPIENS PALLENS

Juemin Song (Sanitary and Anti-epidemic Station of Zouxian County, Shandong 273500, China)

Culex pipiens pallens Coquillett, distributed widely in China, is an important vector of diseases. Knowledge of its gonotrophic cycle is helpful to reveal its ecological habits and of great importance both in epidemiological investigation and working out controlling methods. The results of observations conducted since 1904 in Zouxian County of Shandong provice are as follows.

1. Among the 1409 heads of the mosquito caught after full suction of human blood, 1275 heads oviposited, the remain 214 heads did not and died.

2. The time span from full blood suction to oviposition was 47-1209hr, averaged 122.3hr (5.1d). Taking count of 906 heads which oviposited within 120hr after full blood suction, the oviposition period was mainly in 66-96hr and averaged 79hr after the suction.

3. Observationon the above 906 heads showed that the oviposition was mainly from 18:00 to 6:00 next morning with the peak at 19:-20:00, and 69.5% from the entries oviposited during 18:00-24:00, 27.1% did during 1: 00-6.00. The course of oviposition lasted 10-30min. The egg cluster was like a raft, consisted of 22, 233 and 106.4 eggs in average.

4. The breeding place and water quality could significantly affect the gonotrophic cycle. But other factors might also serve the cause for rhythm disorder of the gonotrophic cycle, so the factors such as amount of sucked blood, temperature and humidity conditions, physiologic difference between individuals, and effect of parasites are also discussed.

#14

SPECIES RICHNESS, RELATIVE ABUNDANCE AND BITING ACTIVITY OF MOSQUITOES IN THE WESTERN ORANGE FREE STATE, SOUTH AFRICA.

T.C. de K. van der Linde (Dept. of Zoology and Entomology), R. van Staden and M.S. Smith (Dept. of Virology) University of the Orange Free State, Bloemfontein 9300 Rep. of South Africa.

Mosquitoes were caught with light traps at weekly intervals in the urban area and district of Bloemfontein. The dominant species were *Culex theileri, Cx. univittatus, Ae. juppi* and *Ae. vittatus*. The first three species are known to be potential vectors of Rift Valley Fever, Sindbis, West Nile and Wesselsbron virus. Heavy rainfalls usually lead to an increase in Culicidae numbers and often to an increase in the incidence of arbovirus diseases.

The biting activity of the mosquitoes were monitored over a 24 hour period. *Aedes* spp. were the first to arrive, starting to feed from 14:00 and reaching a peak at 19:00, and then gradually decreased through the night until 06:00 the next morning. The *Culex* spp. were active from 18:00 until 04:00 in the morning, with the peak feeding activity at 19:00.

#15

IMMUNOLOGICAL STUDIES ON MOSQUITO BITES.

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Mosquito bite reactions are devided into two types; the common reaction and the severe reaction with systemic symptoms. There is an obvious difference between common cases and severe ones in IgG titers to mosquito salivery gland antigens (MSA). The immunoblotting analysis revealed that IgG antibodies in serum samples from the severe cases strongly reacted to wide variety of MSA proteins. Immunoblotting patterns of IgG in those from the common cases were not correlated to the following five stage of cutaneous reaction; no reaction (stage I), delayed reaction (II), immediate and delayed reactions (III), immediate reaction only (IV)and no reaction (V). Immunoblotting patterns of IgG4 and IgE antibodies in the serum samples will be discussed in relation to the stages of common reactions and the severe cases.

#16

OBSERVATION ON ECOLOGY OF THREE SPECIES OF MOSQUITOES.

Xiou chun Chen,Shu-yuan Sai,Guang-ye Hu(Taishan Medical College,Taian,Shandong 271000,China)

Culex pipiens Var. pallens, Anopheles sinensis and Culex tritaeniorhynchus are prevailing among the five species of mosquitoes found in Taian.Culex pipiens var pallens breeds mainly in the gutter along roads and polluted water, and manuer pits water vats serve it as the secondary breeding place.But fresh water pools and slowly flowing streams are the common breeding place for the three soecies.some water ponds are unsutable for breeding of mosquito larvae, and the reason has been found after observation and discussion.

A species of parasitic protozoa was found inside the larva. It was identified with anew species of Genus Gregarinnida,belonging to Class Sporazoa. The larvae parasitized by the protozoon have to die sooner or later and can not emerge. Futher research shall be done about whether the protozoon is a natural enemy or not. The larva appears in the second ten days of April when the temperature of water is at 16℃, and the density peak of larvae occurs in the late ten days of July, then decrease wavily. A few of larvae are found in the middle of December and disappear thoroughly after freeze in the late ten days of December. Filariasis ,malaria and Japanese B encephalitis transmitted by mosquitos were very prevalent several years ago in Taian. But after energetical prevention and treatment, the incidence of Japanese B encephalitis has dropped remarkable. Nevertheless,a few cases still occur. Futhermore malaria and filarasis are not eliminated finally, because patients of the two diseases frequently come from abroad and other provinces may serve as transmitters. Therefore, the mosquito control has to carry out hard on the basis of its ecology. Some suggestions are given for future scientific research on prevention and control.

#17

BREEDING PATTERNS OF COMMON MAJOR MOSQUITO VECTORS IN RUNNING-WATER HABITATS IN ACCRA, GHANA.

By W.A. Chinery, Ghana Medical School, Box 4236, Accra.

This paper compares breeding patterns of Anopheles gambiae s.l. Culex p. quinquefasciatus and Aedes aegypti in the above habitats to determine the impact of rainfall on their relative prevalence which has been appreciably altered by rapid urbanization. The means of larval prevalences of these vectors in the above habitats and mean monthly rainfall between 1964-1966 (when larval control was in progress) were compared graphically, by scatter and the correlation coefficient. For each of the three species, breeding patterns in concrete and earth drains were quite similar but differed from that in stagnant streams. Generally, there was a positive association between larval prevalence of An. gambiae s.l. and Ae. aegypti and rainfall and a negative association between these parameters for Cx. p. quinquefasciatus. For An. gambiae s.l., a significant correlation between rainfall and larval prevalence was observed only in concrete drains during the 1965-66 year (viz. $r = -0.6487$ for $p<0.01$ and $r = +0.8337$ for $p<0.001$ in the rainier and drier months respectively). For Ae. aegypti there was correlation between rainfall and larval prevalence in both earth drains (viz. $r = +0.5969$ for $p<0.02$; $r = -0.9283$ for $p<0.001$ in the rainier and drier months respectively) and stagnant streams (viz. $r = +0.8928$ for $p>0.001$ in the rainier months) in the 1964-65 year. Several ecological factors and larval control affected the three species differently. Thus, impact of rainfall was most marked on Aedes then Anopheles and Culex in that order.

#18

TEMPORAL AND SPATIAL DISTRIBUTION OF ANOPHELES MOSQUITOES AND MALARIA DURING A YEAR-LONG MALARIA VACCINE TRIAL.

Robert S. Copeland, James A. Sherwood (USAMRU-Kenya, Box 401, APO AE 09831-4109, USA and Kenya Medical Research Institute, Box 54840, Nairobi Kenya) K.A. Taylor (Centers for Disease Control, Atlanta, GA. USA),Joseph Koros(Kenya Med. Res.Inst.)

The distribution of Anopheles mosquitoes and malaria infection of these vectors was followed for one year during a Plasmodium falciparum vaccine trial in western Kenya. Overall P. falciparum infection rates, as determined by ELISA of dried head/thorax of individual mosquitoes collected resting indoors, were 14.2% (A. funestus), 10.9% (A. gambiae), and 1.7% (A. arabiensis). Infected A. funestus had significantly lower ELISA optical density values (mean=1.164) than either A. gambiae (1.269) or A. arabiensis (1.250). Ingress into houses of females which had fed elsewhere on humans was estimated for A. gambiae (17.5%). A arabiensis(4.2%), and A. funestus (8.2%). Anopheline densities were highest in houses located near small valleys containing seasonal streams. This effect was strongest during the dry season, while mosquito distribution was more diffuse during the rainy season. For all three Anopheles species, malaria infesction was distributed uniformly between females which had fed on humans and those which had fed on cows, suggesting the absence of subpopulations of these species with different feeding behaviors. Neither Anopheles species nor P. falciparum infection was distributed uniformly among collection houses or over time. The relevance of these data to the design and interpretation of malaria vaccine trials is discussed.

#19
SEVERAL TYPES OF PERIODICITY IN TEMPORAL FLUCTUATIONS OF MOSQUITO POPULATION CHARACTERISTICS
N.V.Nikolaeva (Institute of Plant & Animal Ecology, 620219 Sverdlovsk, USSR)

Long-term investigations were carried out in the South Yamal, Aedes communis Deg. and A.hexodontus Dyar being dominated in floodplain forest and tundra habitats correspondingly. The most strong increase in population size of larval mosquitoes as well as in numbers of biting females seemed to have a periodicity of 10 years, while the moderate fluctuations of these characters took place every 2-4 years. A 3-year successive increase and decrease of mean pupal weight within mosquito populations were registered that coincided with decrease or increase of their mean developmental period. Besides of a diurnal rythm of activity, the distinct 3-5-day periodicity in female biting and migratory activities had been determined.

#20
ON THE ECOLOGY OF ANOPHELES PULCHERRIMUS IN GHASREGHAND, BALUCHISTAN, IRAN. M.Zaim, K. Pakdad, G. Mowlaii, M. H. Kaydi, A. V. Manouchehri, M. Motabar, Gh. Edrissian, H. Ladonni, M. Nazari (School of Public Health, P. O. Box 6446, Teheran 14155, Iran).

Studies were carried out on the ecology of An. pulcherrimus, the 2nd most common anopheline species in Ghasreghand, from May 1990 to March 1991. Outdoor human and cattle biting rates ranged between 0 to 2 and 5 to 119, respectively. The species showed one peak of biting activity in early fall and almost 75% of the biting activity occurred before the midnight. Out of the total of 357 blood smears from females captured by different sampling methods, only 1.12% reacted with human antiserum. This species was found mainly exophilic. No significant difference was noticed between the no. of females caught in the inlet window traps installed on human and animal shelters. However the no. of females caught in outlet traps of animal shelters was significantly higher than that of human dwellings. Peak entrance of empty females into indoor resting sites was in 2nd and 4th quarter of the night whereas that of freshly fed females was in the 4th quarter. Peak exit of gravid females from indoor resting sites was found to be in the 1st quarter of the night. Light traps (LT) located in human and animal shelters as well as in the middle of the village caught 76% of the total females as compared to pyrethrum space spray catches (PSSC) of human and animal shelters and pit shelter collections. However 81% of LT were empty females, whereas 57% caught by PSSC were semigravid or gravid individuals.

#21
COMPARATIVE STUDIES ON THE ADULT PROTEINS OF FOUR GEOGRAPHIC STRAINS OF CULEX PIPIENS COMPLEX. Jin-bo Qiu, Li-shou Yang, Jia-xu Chen, Wei-zhu Yang(Zhenjiang Medical College, Zhenjiang 212001 ,China)

We compared the adult proteins of four geographic strains of Culex pipiens complex from Zhenjiang, Qingdao, Jinan and Yantai by polyacrylamide gel electrophoresis (PAGE). At the same time, we compared further the adult proteins of Cx. pipiens pallens from Jinan and Yantai by thin-layer isoelectric focusing (IEF). The results are as follows: As a whole, no significant difference was observed among the mosquitoes in electrophic bands of the adult proteins. There were some particularities in the protein electrophoresis scanning figures of Cx. pipiens pallens from Qingdao, Cx. pipiens quinquefasciatus and intermediate form from Zhenjiang. The phenomena mentioned above were closely related to the ecologic environment and genetic gene respectively, but their protein electrophoresis bands were all similar. Therefore, the differences among them didn't exceed the subspecies level for the four geographic strains of Cx. pipiens complex. In addition, thin-layer IEF technique is better than PAGE method, as the former is worth the popularization.

#22
PRELIMINARY CONSTRUCTION AND RECOMBINANT CLONING OF *CULEX PIPIENS PALLENS*. Xiao-lin Lu, Zhong-xiang Liu, Yi Weng (Department of Parasitology, The Fourth Military Medical University, Xi'an 710032, China)

Culex pipiens complex is widespread in China., and have close relation with human life. *Culex pipiens pallens* and *Culex pipiens quingefasciatus* are important vectors of diseases. *C. pipiens pallens* is distributed in north and *C. pipiens quingefasciatus* in south according to 33 degree north latitude. In addition, there is transition species around 33 degree north latitude. It is difficult even for experienced eye to distinquish isomorphous species. DNA probe provides specific and sensitive method to identify isomorphous species. We extracted genomic DNA of *C. pipiens pallens*, and measured the DNA contents by agarose gel eletrophoresis and prepared large amount of PUC_{12} plasmid DNA. Genomic DNA of *C. pipiens pallens* partly digested by Sau3A was ligated with BamHI to PUC_{12} at the BamHI site with T_4 DNA ligase, approximately 500 recombinant clones of *C. pipiens pallens* were produced and constructed in laboratory.its genomic DNA labeled with ($a-^{32}P$) dATP was hybridized in situ by Nick-Translation. We obtain 7 clones of *C. pipiens* genomic recombinant clones and laid foundation for identify *C. pipiens* complex by molecular bilogical method.

#23
A PRIMARY STUDY ON THE AMOUNT CHANGE OF FATTY ACIDS INSIDE CULEX QUINQUEFASCIATUS DURING ITS DEVELOPMENT. Ming Wei, Ju-sheng Wang (Guiyang Medical College, Guiyang, Guizhou 550004. China)

By using gas chromatography, mainly eight fatty acids were detected in different developing stages and structures of Culex pipiens quinquefasciatus including egg, egg shell, larvae, pupae, puparium, ovary of stage V and adults with different ages of day. The principle fatty acids were palmitic acid and oleic acid which presented in all stages. The amount of palmitic acid rose gradually during mosquito's development, but oleic acid was decreasing. Arachidonic acid occurring in all stages except ovary V and newly emergenced adult male. C24:0 was only detected in newly emergenced adult female and females who got a blood meal 5 days ago. Lauric acid was detected in 4th instar larvae, pupae, female adults of different ages and male adults with ages of 7 and 15 days. Linolenic acid was detected in egg, egg shell, puparium, and larvae of 1-3 instars. Linoleic acid only present in male pupae and cardamom acid only in ovary of stage V.

#24
PRODUCTION AND ACTIVITY OF ANTI-SERA AND MONOCLONAL ANTIBODIES RAISED AGAINST THE VECTOR MOSQUITO, ANOPHELES STEPHENSI. A.P.G. Almeida and P.F. Billingsley, Department of Biology, Imperial College of Science, Technology and Medicine, Prince Consort Road, London SW7 2BB, U. K.

BalbC mice were immunised with extracts of Anopheles stephensi midguts, ovaries of heads . Three inmmunisations at four week intervals were performed, and after each one, mosquitoes were allowed to feed on the immunised mice. Post-feeding mortality was increased after the first immunisation, but this effect was lost after the subsequent boosts. The timing and quantity of eggs laid were delayed and decreased respectively only following the second boost. Again this effect was subsequently lost.

Using mosquito abdoments as the antigen, sera from all mice were reactive (dilutions of 1: 2000) in dot bolts. Further cross-reactivity was observed in Western blots, but some midgut-specific antigens were recognised.

The spieenocytes from midgut-immunised mice were subsequently fused with a mviloma cell line and fused cells selected and tested for production of monoclonal antibodies. Four such monoclonal antibodies were isolated, and on a proliminary-feeding experiment one of these showed increased mortality in the mosquitoes feeding upon it. In IFAT, the monoclonal antibodies recognised muscle networks in the midgut and Malpighian tubules, the midgut epithelium, the germinal cells of the ovary, and the basal lamina of the anterior midgut in Westerm blots , these monoclonal antibodies recognised only nonreduced protein from the midgut, but both reduced and nonreduced proteins from other tissues.

#25

STUDIES ON THE VECTORS OF ENCEPHALITIS B AND THE DISEASE DISTRIBUTION TOWARDS NORTH IN FRIGID REGION OF CHINA. Shu-po Lin (Heilongjiang Hygiene and Anti-epidemic Station, Harbin 150036, China)

Encephalitis B is an infectious disease transmitted in China and other countries. A lot of research work has beeb done on the vectors of the disease. It was found that mosquito Aedes vexans was a predominant vector of the disease in high latitude region of China. The survey also proved that the disease has a tendency to distribute towards north area of China. Results provided some references to the feasible control of the disease.

#26

TRANSMISSION OF MALARIA IN A TANZANIAN VILLAGE, AND ESTIMATION OF THE HUMAN INFECTIOUS RESERVOIR. The Kilombero Malaria Project, Ifakara Centre, Tanzania and the Swiss Tropical Institute, Basel, Switzerland. P. F. Billingsley, Department of Biology, Imperial College of Science, Technology and Medicine, Prince Consort Road, London SW7 2BB, U.K.

Mosquito populations have been monitored for over two years in Namawala Village (Kilombero District,Tanzania) as part of the kilombero Malaria Project. The two major vectors in the region, Anopheles gambiae s. l. and Anopheles funestus undergo typical seasonal fluctuations associated with rainfall. Within the village, population densities vary tremendously between household, those on the periphery of te village and in outlying areas often having over a thousand mosquitoes per night compared to just 1-10 houses at the heart of the village.

Using bednets with holes out into them, mosquitoes could be collected that were known to have fed on a identifiable bloodmeal source(s). These mosquitoes were collected from nets placed at random throughout the village, then held for 5-7 days to allow development of oocysts . At this time, midguts were dissected into mercurichrome and the number of oocysis per midgut counted. The proportion of nets containing infectious individuals varied from O in December (n = 5) to 69% in June (n =71) . There was no apparent correlation between proportion of infected mosquitoes and mosquito densitie within the village. Similarly, the sporozoite rate was the same in mosquitoes throughout the village collected at any one time, indicating that a single dispersed mosquito population is responsible for all transmission.

#27

EXPERIMENTAL HUT TRIALS FOR KILLING EFFECTS AND BEHAVIOURAL RESPONSE OF PERMETHRIN-IMPREGNATED BEDNETS ON ANOPHELES SINENSIS AND CULEX TRITAENIORHYNCHUS IN CHINA. Pan Bo,Li Zuzi, Wu Yuguang (Institute of Anti-parasitic Diseases of Guangdong Province, Guangzhou, China. 510300)

The mortalities of more than 50.5% from An. dirus and An. sinensis in the residual bioassay were botained from the 500mg ai/m^2 permethrin-impregnated bednets in 11 and 17 months after treatment. The 500mg ai/m^2 permethrin-impregnated bednets were tested against populations of An. sinensis and C. tritaeniorhynchus in experimental huts fitted with exit-window traps to catch samples of the mosquitos exiting during the night. The average mortality of An. sinensis and C. tritaeniorhynchus were 78.9% and 80.2% with the treated net one year after treatment and were 84.5% and 94.5% with the perforated treated net 7 months after treatment respectively. By comparison with the control hut, the perforated treated net reduced the fed rate by 44.9% for An. sinensis and by 66.9% for C.tritaeniorhynchus. Meanwhile, the entry rate of An. sinensis and C. tritaeniorhynchus were reduced by 77.4% and 76.7% with the 500mg ai/m^2 permethrin-impregnated net, but it was not reduced with the 25mg ai/m^2 daltamethrin-impregnated net. The Conbined-response Index of permethrin-impregnated bednets on epodemiology were that: $\{1 - (\text{House entry rate} \times \text{Fed rate} \times \text{Survival rate})\} \times 100$ For example, the Combined-response Index of permethrin-treated bednet on An. sinensis was: $\{1-(0.226 \times 0.015 \times 0.289)\} \times 100=99.9$

#28

BEDNETS: AN ALTERNATIVE METHOD TO CONTROL MALARIA IN WESTERN VENEZUELA? Yasmin Rubio-Palis (Division de Investigaciones, Escuela de Malariologia, Apartado 2064, Maracay 2101-A, Venezuela)

Malaria transmission has persisted in western Venezuela even though houses has been regularly sprayed with insecticide. DDT was used in the area between the 1940's and 1984-85 when there was a change to fenitrothion. A longitudinal study conducted in three villages in western Venezuela near the border with Colombia has shown that the most abundant species and the incriminated vector is *Anopheles nuneztovari*, comprising up to 70% of the total anophelines collected. This species has a biting peak around mid-night; is endophagic and extremely exophilic and this is presumably why no effects of fenitrothion were observed on mosquito density or on parous rate. Questionnaires to householders revealed that most people go to bed before 2200 hrs and wake up before 0700 hrs. Recent studies in Tanzania and China have shown that the use of pyrethroid impregnated bednets are effective in reducing malaria transmission. The wide use of insecticide-treated nets in western Venezuela should be considered as an alternative method to reduce malaria transmission due to *An. nuneztovari*.

#29

EFFECTS OF SOLIDIFIED LIQUID MOSQUITO-REPELLENT INCENSE AGAINST MOSQUITOES. Wu-yang Miao, Guo-xin Shu, Fu-shuang Lü, Wang-cai Cui (Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing, China)

The solidified liquid electric mosquito-repellent incense (SLEMRI) is made up of two parts: automatic controlled apparatus and a small aluminium pit (20 mm in diameter). Insecticide esbiothrin in a controlled-release formulation is added onto the pit.

The knockdown activity in a glass cabinet (0.343m^3) and the protective effect of SLEMRI in room against mosquitoes were investigated. Mean KT_{50}s of SLEMRI against female A.aegypti, A.albopictus, A.dirus, C.tritaeniorhynchus, C. quinquefasciatus and C. pipiens pallens after 20 minutes exposure were 2.0, 3.2, 2.8, 2.4, 5.0 and 5.9 minutes, and mortalities (24hr.) were 100, 81.2, 99.0, 100, 35.3 and 20.3%. respectively. Mean KT_{50}s of SLEMRI to free-flying mosquitoes (C.pipiens pallens) after 7 hours exposure in two rooms (41.2-54.2m^3) with the door and windows closed were 20.4-25.2 minutes and mortalities(24hr.) were 95.0-95.4%. KT_{50}s in above rooms with windows opened were 27.0-58.5 minutes, and mortalities (24hr.) were 82.6-83.4%. The protective effect of SLEMRI to individuals in the room (24hr.) was 91.5%.

#30

STUDY ON KILLING EFFECT OF INSECTICIDE GAUZE TO MOSQUITOES AND FLIES. Wanhong Qian, Xuezhoug Zhao, Zhikuan Jiang, Yinkuo Zhang, Minrong Bao (Institute of Military Medicine, Nanjing 210012, China)

This paper reports a new screen called as Sanitary Insecticidal Gauze which prepared by using a controlled-release technique, according to that mosquitoes and flies have a characteristic of phototropism, i. e., they fly towards light again and again. The new gauze have not only the convertional physically protective effect but a new chemically protective effect. It has a strong power for hitting and killing such pests as mosquitoes and flies in 30 seconds or more with 100% of death rate in duration of about two years. It has no special smell with wash resisting and sun resisting, and is safe for both people and animals with low price. It is a new good method for killing such pests as mosquitoes and flies in room, and can be widely used.

#31

EFFECTIVENESS OF ROMANOMERMIS YUNANENSIS, AN ENTOMOPHILIC NEMATODE AGAINST MOSQUITO IN VARIOUS ECOLOGIC REGIONS. Jinzhang Song (Institute of Military Medical Sciences, Chengdu Military District, Chengdu 610061, China)

In 1984, Romanomermis yunanensis was discovered in China (Song & Peng, 1987) and has been passaged for more than 100 generations under laboratory conditions. Experimental infections showed that culicine mosquito were highly susceptiable to R. yunanences.

Field tests of R. yunanensis were conducted in Sichuan, Yunan and Henan during 1986 to 1991. The results of field application of R. yunanensis in a tatol of 704 m^2 paddly fields, 90 m^2 of ponds and 32 streams showed that the parasitism of Culex tritaeniorhynchus ranged from 52 to 92%, that of fatigans from 36 to 90% and that of theirs 30 to 93%, when the parasite application rate was 2000-40000 per square meter. A good result was achieved in control of Aedes albolitas breeding in pots and old wheels, when the parasite application rate was 1000 per container, most of them parasitism reached 80%. Safety test showed that 50, 100, 200 and 500 preparasitic juveniles of R. yunanensis were exposed to mice respectively, no sign of infection was noted.

Although more extensive field trials are essential, these data are encouraging for further development of nematodae for mosquito control both in China and other regions with serious mosquito control problems.

#32

THE ADVANTAGES OF MOSQUITO BIOCONTROL BY STOCKING EDIBLE FISH IN RICE FIELD. Neng Wu (Institute of Parasitology of Guanxi Province, Naning 530021, China)

Edible-fish which stocked in rice field at a rate of 600-800 fry per mu (1 mu=1/ 15 hectare) for 150-170 days, may act as an effective mosquito biocontrol agent. It kill the alrvae at the later stage of the compensation of larvae, hence they should have a greater effect in reducing the population of mosquito. The expansion of fish stocked in paddies was directly related the suppression the malaria transmision, data from successive ten years observation showed that these two parameters have a very significant regression coefficent; r=-0.9348.

Rice field is arranged in ridge for rice and ditch for fish may be benefit both for rice plant and fish. The chemical and physical properties of soil in rice field compared with the paddies without fish the total nitrogen +13. 7%*; effective phosphorous +14.3%* ; effective potasium +16.7%*; oxidation reduction potential +37.5%** ; cultivated area -16.8%**; wild grass -99.4%**; per mu. Nitrogen in leaf +16. 3%* ; phosphorous in leaf +14%*; potasium +16.9%*; chlorophyll content in leaf +16.2%**; activity of root system +34.8%**; effective grains per ear +18.7%** . The economic benefit after fish stocked in paddies as follows: rice yeild +9-10%; fish yeild 44.4 kg/mu. The total earning was increasing to 258.37 yun/mu which was increased 52% as compared with check.

#33

INTEGRATE CONTROL OF VECTOR MOSQUITOES WITH NATIVE FISHES (APLOCHEILUS AND APHYOCYPRIS) AND BACILLUS THURINGIENSIS(H-14) IN NATURAL RICE AND PARSLEY FIELDS OF KOREA Hyo-Sok Yu(Div.of Appl. Entom.,Dept.of Agricultural Biology, Seoul National Univ., Suwon 441-744,Korea) and Hung-Chul Kim (Dept.of Biology, Kyung Hee Univ., Seoul 131-050, Korea)

Field assessments on the integrated control of mosquito vectors (Culex tritaeniorhynchus and Anopheles sinensis) was conducted with native fish (Aplocheilus latipes or Aphyocypris chinensis)integrated with B.t.(H-14) in natural rice and parsley fields at Yongam, South Korea in 1988 and 1991.

In rice paddies, the natural presence of Aplocheilus at 0.6 fish1/M^2 yielded 55.0-57.6% control from July-August; B.t.(H-14) treatment at 1.0kg/ha resulted in 100% mosquito reduction in 24 hrs., and the control sustained above 98% until October 11. In rice paddies where another lavivore, Aphyocypris chinensis were introduced at 1.5 fish/M^2, a satisfactory degree of biological control (88.2-96.7%) was obtained until september, 1988.

In parsley fields, Aphyocypris introduction at 0.8 fish/M^2 resulted in 40.9-60.2% mosquito reduction in 5 week period, however, the vector larval density began to increase in mid-September : an integrated B.t.(H-14) treatment at 1.0kg/ha made 100% control in 24 hrs., and subsequently maintained a satisfactory level of mosquito suppression (89.0-94.9%) until October, 10,1991.

#34

THE EFFICACY OF NOVEL STRAINS AND MUTANTS OF BACILLUS THURINGIENSIS AGAINST MOSQUITO AND BLACK FLY LARVAE. G. Charpentier, M. Boucher, A. Pagé. (Département de chimie-biologie, Université du Québec à Trois-Rivières, C.P.500, Trois-Rivières, Québec, Canada, G9A 5H7), J-C. Côté, S. Fréchette (Agriculture Canada, St-Jean-sur-Richelieu., Québec, Canada, J3B 3E6), H.-S. Kim, Y.S. Chung (Département des sciences biologiques, Université de Montréal, Montréal, Québec, Canada). In order to find another microbial insecticide for black fly and mosquito larvae control instead of Bacillus thuringiensis subsp. israelensis (B. t. i.) in case of developing resistance, we tested two other subspecies of B. thuringiensis (the subsp.morrisoni strain PG14 and the subsp. Hyl). These two strains were obtained as acetone extract powder from the "Institut Pasteur" (Paris, France). Laboratory experiments on Simulium vittatum (Diptera: Simuliidae) were conducted with a modified version of the "Jar tests" technique from Jamnback . Bioassays were done at 5° with a contact time of 30 min. to various dilutions. Thirty Aedes triseriatus (Diptera: Culicidae) larvae in 100 ml of non-demineralized distilled water were exposed to bacterial dilutions in plastic specimen containers at 25°C for 24 hours. Their efficacies were compared to the one of a primary powder of B. t. i. (IPS 82 from the "Institut Pasteur"). The LC_{50} were respectively 0.064 mg.L^{-1} for IPS 82, 0.68 mg. L^{-1} for Hyl, and 4.0 mg.L^{-1} for PG14 strains against S. vittatum. For mosquito larvae the LC_{50} were 0.028 mg.L^{-1} for IPS82, 0.98 mg. L^{-1} for Hyl, and 2.4 mg. L^{-1} for PG14. These two strains of B.thuringiensis are toxic for mosquito and black fly larvae. In both case the Hyl strains seems to be more toxic than PG14 strain but these strains are less toxic than the internatinal standard of B. t. i. We are now testing asporogenous mutants of B t. i.. Some seem to be more potent than the original strain.

#35

INVESTIGATION INTO VERTICAL DISTRIBUTION OF FLIES ON MOUNT TAI . Taisheng Wang, Shugong Zhao, Wenguo Wang, Aikun Tian and Yonghui Liu (Health and Epidemic Prevention Station of Taian, Shandong, China.271000)

90177 adult flies have been collected on Mount Tai in the last five years.They belong to 90 species. 44 genera and 5 families .Among them, 21 species are first found in Shandong Province .About half of them belong to species of Palaearctic realm .The percentage of eastern flies in these species is about 63% and that of the oriental flies is about 32% .However, worldwide distributed species of flies are seldom found in these areas. Some species of flies such as Gymnodia ascendens (stein), Lucilia bazini (S'eguy), L.sinensis Aub, Pierretia Gracilforceps (thomas) which only exist in southern China, and some species existing only in northern China such as Protophormia terraenovae (R-D) , Paregle audacula (Hurris) , Anthomyiidae imbrida Rond, Anthomyiidae Pluvialis are now found in this area. The density of cold tolerant flies as Hydrotaea dentipes (Fab) and Aldrichina graham (Aldr.) is in direct proportion to the elevation of Mount Tai.They are able to reproduce at the height of 1, 500m, but they are seldom found at a height of 180m in Taian city.The average temperature difference from the top to the foot is about 7-8°C because of the monsoon wind. The cold and moisture condition is suitable for these flies to develop. Musca domestica living in this area has a close relationship with human life.Their density is in inverse proportion to the elevation of Mount Tai.Most of the flies such as Hydotaea dentipes, Aldrichina graham, Bellieria etc.begin to appear in April and May. Lucilia sericata and Musca domestica occur from April in the city area, and from May on the top of Mount Tai.The first peak of fly desity was found in June at the city area, Dou Mugong and the top of Mount Tai, the second peak was found in September.Only a few species of flies appear from December to March of the following year. According to the seasonal distribution of flies, different measures have been adopted to control them and the density is found to be dropping year after year.

#36

DIGESTION AND PASSAGE INTO HAEMOLYMPH OF HOST IMMUNOGLOBULIN G IN THE AUSTRALIAN BUFFALO FLY. P.G. Allingham, R.L. Kerlin, D.H. Kemp (CSIRO Division of Tropical Animal Production, Long Pocket Laboratories, Indooroopilly, Q. Australia.)

An understanding of the fate of antibody ingested by haematophagous arthropods is central to the development of vaccines against these pests. Flies were fed blood *in vitro*. Gut or haemolymph samples were taken at various times post-meal. On average buffalo flies ingested 1 μl of blood in the first meal. Rate of digestion of soluble protein was linear over time (approx. 30 μg/hour) with a half-life of 1-2 h. Similarly, the half-life of Ig and specific antibody activity in the gut was 1-2 h. Immunoblots of gut contents suggest that intact IgG was present up to 2 h after feeding. At 4 h only large fragments of IgG were discernible on immunoblots and by 6 h only small fragments were detected. In haemolymph, Ig and antibody levels increased rapidly in the first hour post-feed then decreased linearly over the next 4-5 hours. Ig, at very low levels, was still detected 24h later. A high proportion (94%) of flies had detectable levels of Ig present in the haemolymph. Approximately 1/1000 of ingested antibody passed into the haemolymph where it retained activity as shown by ELISA. Analysis of haemolymph samples taken at intervals from flies fed blood *ad libitum* for 96 hours indicated levels of IgG in haemolymph in the order of 10^{-8}M. Consequently one aim of a vaccine against buffalo fly, which has potent digestive proteases, would be to stimulate the production of anti-protease antibodies. This should enhance the ability of specific antibodies to target antigens in the gut or haemocoel.

#37

SEASONAL MIGRATION AND AESTIVATION IN THE UNIVOLTINE BLOW FLY, CALLIPHORA NIGRIBARBIS VAN VOLLENHOVEN. H. Kurahashi, S. Kawai and C. Shudo (National Institute of Health, Tokyo 141, Japan)

Calliphora nigribarbis is an eastern Palaearctic species, with a distribution from eastern Tibet, across northern China and Korea, to Japan. In Japan, this blow fly is one of the common synanthropes bred in Japanese privies, garbages and domestic animal houses.

Field study in Hachijo Island, Tokyo, showed this fly was a short-day univoltine insect whose development continued for 6 months (December to May). Adults appeared from November to June in towns (alt.50m) and from October to July in the montane moss forests of Mt. Hachijo-Fuji (alt.850m). The number of flies at the upland gradually increased during February to April and then decreased. After the rainy season in June, no adults were trapped throughout summer in both lowlands and uplands. No developing stages were also observed from June to November in both habitats. The first appearance of aged males and females in moss forests in October, suggests that adults aestivate there. After aestivation some females migrate from uplands to lowlands for spawning eggs. The lowland population emerged in spring migrates to uplands for aestivation. This up-and-down seasonal migration was confirmed by the release and recapture of marked flies. The laboratory experiment showed the reproductive (ovarian) diapause was induced by a long-day and low temperature (below 20°C, critical day length 12hr 45min). Adults escape from lowlands to enter diapause.

#38

Simulation of two Dipteran pest species, *Lucilia cuprina* and *Musca vetustissima*.

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CSIRO, Canberra, Australia

The Australian sheep blowfly, *Lucilia cuprina*, is a serious pest of the sheep industry with control measures costing over US$120 million a year. The bushfly, *Musca vetustissima*, is a nuisance pest of humans affecting the tourist industry in the summer months. Computer models of these species are being developed as aids in pest management. The current models predict the seasonal abundance of flies from meteorological data for a locality. Provision is made to allow for immigration of flies from other areas, an important factor in the dynamics of bushfly populations in cooler regions of Australia. The bushfly model also incorporates estimation of dung quality and dung beetle abundance, which influence survival of the immature stages. The sheep blowfly model uses routines for calculating diurnal temperature variation at different soil depths to model the pupal stage. Future development of the models will incorporate application of genetic and conventional control methods to assess their effects.

#39

A STUDY OF INTEGRATED CONTROL FOR ELIMINATION FLIES AND COMING UP TO STANDARDS IN THREE CITIES OF JILIN PROVINCIAL Lanying Gao, Enjun Shu, et al. (Hygienical and Disease Prevention Center of Jilin Province, Changchun 130021, China)

Since 1989, we have taken Jilin City as an experimental point of killing flies and coming up to standards and carried out a research of multiple steps of prevention and control for eliminating flies and coming up to standards in three different level cities: Changchun (large) Hunjiang (middle), Yanji (small). The total population of three cities is 4.335 million, the total area is 277 square km.

Integrated preventive and controlling work steps of killing flies in Jilin Provincial Cities (one year) are as follows: 1. Preparatory stage (Feb. -Apr.): 1)Implementing work plan training professionals; 2) Overall basic investigation treating breeding places; 3)Collecting insecticide killing adult-flies. II. Implementing stage (May.-Sep.): 1) Sunerllance of fly density; 2) Susleptibility and anti-drag test; 3) Overall conducting preventing and controlling measures; 4) Killing flies by using insecticide two times; 5) Checking the work of killing flies. III. Consolidating stage (Oct.-Jan.): 1) Go on treating, supervising and ruling breeding places; 2) Killing overwintering flies; 3) Summary, demonstration and evaluation.

On the basis of the work killing flies and coming up to national checking standards of Jilin City in 1989-1991, the authors discussed comprehansive measures and the results.

#40

EFFECT OF KILLING FLY IN PUBLIC LAVATORY ON THE FLY DENSITY IN ENVIRONMENT. Sumei Huo (Shanxi Hygienic and Anti-epidemic Station, Taiyuan 030012, China), Zhuangxing Ma (Shanxi Academy of Agricultural science, Taiyuan 03006, China)

The public lavatory in Taiyuan City in Shanxi built by bricks and adobes is the main place for flies. The high density of them is during the first ten-day period of June and the medium of August and September. The index is 19.1 and 25.2, respectively. The main species are Musca domestica vicina, Lucillia sericata, Muscina stabulans. The restraurant in the centre of the city was selected as a testing place. 5 ppm Deltamethrin was applied at 369 W. C. in 2X2 Km for twice during Aprit and June. The results showed that the density index decreased to 11. 6 and 21.3 and the duriation shorten. Insecticide application had a good effect on decrease of fly density.

#41

AN ANALYSIS ON INSECTICIDE RESISTANCE OF MUSCA DOMESTICA IN SHANXI. Jinxia Cheng (Shanxi Hygienic and Anti-epidemic Station, Taiyuan 030012, China) Zhuangxing Ma (Shanxi Academy of Agricultural Science, Taiyuan 03006,China)

This paper shows the analysis of the results of the determing insecticide resistance of Musca domestica vicina in Shanxi. For Deltamethrin, the resistance trended to be up and fast, one degree to go up per year in Datong and Xingzhou city, but on the whole, it's lower than other provinces in China. For Permethrin, in the testing places threre were 80% sensitive place and 20% low-resistance places. For Dichlorovos, there were the high-resistance in all the testing places. The resistance in allthe places developed steady.

#42

FACTORS AFFECTING THE NUMBER OF *CULICOIDES* IN TRUCK TRAPS IN COASTAL SOUTH-EAST QUEENSLAND, AUSTRALIA. D.S. Kettle, P.B. Edwards (Department of Entomology, University of Queensland, Queensland 4072, Australia), A. Barnes (Tropical Health Program, University of Queensland, 4072, Australia)

On selected evenings truck traps were towed for 15 min over a 6 km route hourly from 1600 to 2100 (the time being adjusted so that sunset always occurred at 1800). Collections were made every 2 days over 4 lunar months at 3 monthly intervals (61 evenings; every 14-15 days to coincide with neap tides, 29 evenings over 14 months), and on 5 separate occasions spread over 12 months, collections were made hourly for 24 hours.

Meteorological data (temperature, wind speed, saturation deficit and cloud cover) were recorded every 30 min from 1555 to 2125 and the maximum tide height for the day taken from tide tables. More than 29,000 *Culicoides* were collected belonging to 9 species, including *C. brevitarsis*, a pest of livestock and vector of arboviruses, and the man-biting *C. marmoratus*.

Models were fitted to these data to attempt to relate the observed variations in numbers of each species caught to environmental factors. Sine curves for annual, lunar and tidal cycles were fitted to the data to explain day to day changes and linear and quadratic regressions, involving meteorological factors and time of day, to explain within day variations. Sample results will be presented.

#43

RE-EVALUATION OF FAINT WING MARKINGS AS THE TAXONOMICALLY IMPORTANT CHARACTER IN THE SUBGENUS AVARITIA OF THE GENUS CULICOIDES (DIPTERA: CERATOPOGONIDAE). Shigeo Kitaoka (Niigata Sangyo University, Kashiwazaki, Niigata, Japan 945-13).

The subgenus Avaritia consists of a unique group in the genus Culicoides which each of all developmental stages has the distinctive morphological character. From epidemiological point of view, the potential vectors or incriminated ones of many kinds of veterinary-important animal viruses were reported that they belong to Avaritia, such as C. imicola, C. brevitarsis and their related species in Africa and Japan to Australia through Southeast Asian areas. Previously, as many as about 25 species of Avaritia were recorded from Japan to Australia. Females of several species were differentiated from know similar ones by presence or absence of faint patches or streaks on the wing. Such characteristics of males more vague, but each species manifests specific structure of genitalia. As the result of our careful examination on Zambian species of Avaritia paying attention to formerly missed character, about seven new species similar to C. imicola were made to join in relatively poor African fauna of Avaritia. Almost light-trap samples collected in different localities were found to be mixed populations with C. imicola and several related species.

#44

EFFECTS OF PYRETHROID TREATMENTS OF CATTLE ON HORSE FLIES (DIPTERA: TABANIDAE) POPULATIONS. D.J. Leprince, L.D. Foil (Department of Entomology, Louisiana State University Agricultural Center, 402 Life Science Building, Louisiana State University, Baton Rouge, Louisiana USA 70807-1710)

The parity rates of Tabanus fuscicostatus populations trapped near untreated cattle increase through time, while the parity rates of T. fuscicostatus populations near cattle treated with pyrethroid sprays decline or remain constant. These results indicate that a segment of the T. fuscicostatus populations returns to the previous location for a subsequent bloodmeal, and the impact of this portion of the population can be reduced with appropriate treatments. Evaluation of sublethal and lethal effects of pyrethroids ear tags and spray treatments of cattle were evaluated against horse flies in Louisiana, USA. In one study, tabanid mortality rates were 3% in control, 9% in permethrin tag, 15% in fenvalerate tags, 67% in 0.01% fenvalerate spray and 79% in 0.02% fenvalerate spray treatments. A 0.05% fenvalerate spray of cattle, reduced natural feeding time and engorged weight of T. fuscicostatus by 30% without preventing blood-feeding. In another study, mortality of T. fuscicostatus flies engorged to repletion on lambda-cyhalothrin tagged bullocks or placed on treated bullocks (without feeding) for periods of 60, 45, 30 and 15 s were equal or greater than 96% while from 0% to 8% mortality was observed in flies that were exposed to hairs or engorged on control bullocks, respectively. As residual levels of pyrethroid treatments reduces through time, the proportion of the target population subjected to sublethal effects is increased. In a mark-recapture study, we estimated that of the flies exposed to a sublethal knockdown dose of fenvalerate while feeding on sprayed cattle, 75% survived and attempted to seek a subsequent host.

#45

CHARACTERIZATION OF THE AQUATIC GLUE PROTEINS OF BLACK FLIES (DIPTERA: SIMULIIDAE). Charles L. Brockhouse, and Robert M. Tanguay. (Insect Biotech Canada and Laboratoire de Génétique Cellulaire et Moléculaire, Centre de Recherches du CHUL, Ste-Foy, Qc., G1V 4G2, CANADA).

The aquatic larvae of the black fly secrete copious amounts of a protein glue which is used for attachment to substrates in currents. In the genus *Simulium,* there are two major size classes of salivary gland proteins (sgps) visible on SDS-PAGE: 35-45 kD ("low MW sgps") and 70-100 kD ("high MW sgps"); these are produced by the larvae constitutively, regardless of current velocity. The exact sizes and number of sgps in each size class varies between species. We have raised polyclonal antibodies against both size classes from the species *Simulium (Simulium) decorum.* Both antibodies crossreact with sgps of species throughout the genus *Simulium* (including species in the subgenera *Hemicnetha, Hearlea, Shewellomyia, Psilosum and Edwardsellum*). The anti-low MW antibody shows no cross-reactivity to sgps produced by species in the genus *Prosimulium.* A low level of cross-reactivity was observed with the anti-high MW antibody. In at least four species of the genus *Prosimulium* (*P. fuscum, P. mixtum, P. multidentatum,* and *P. magnum* s.l.), the sgps are produced only in the presence of a current. Sgp production ceases within days of the larvae being removed from flowing water; production is restored when the larvae are returned to moving water. This may reflect an adaptation in *Prosimulium* larvae for increasing glue production when faced with a rapid increase in water velocity caused by spring run-off.

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#46

THE BLACKFLIES (DIPTERA: SIMULIIDAE) FROM FUJIAN PROVINCE. Tao Zhang & Dun-qing Wang (Department of Parasitology, Fujian Medical College, Fuzhou 350004, Fujian, China)

This paper dealing with sixteen species of blackflies collected from Fujian Province, including one new species, one new subspecies and two new records. The male of S. nodosum Puri, 1933 and the larva of S. hirtipannus Puri, 1932 are described here for the first time. The known species belong to the genus Simulium Latreille s. l.: subgenera Eusimulium Roubaud (two species), Gomphostilbia Enderlein (one species) and Simulium s. str. (nine species). Other four species are under identification. Keys to all known stages are presented. Brief notes for each species are given on taxonomic affinities with related species, their distribution and aquatic habitates of larvae and pupae also listed.

#47

PRELIMINARY STUDIES ON LABORATORIAL COLONIZATON OF *SIMULIUM (EUSIMULIUM) AUREOHIRTUM* (DIPTERA: SIMULIIDAE). Ji-yao An, Ge Yan (Institute of Microbiology and Epidemiology, AMMS, Bejing 100071, China), Bao-shan Hao, Li-xian Yang, Zhen-quan Mai, Cha-tian Liu (Hygienic and Anti-epidemic Team of Guangzhou Command, Guangzhou 510500, China)

A recirculatory water trough apparatus for rearing black fly (Diptera: Simuliidae) immatures is herewith presented in this paper. With the equipment introduced *Simulium (E.) aureohirtum* has been successfully raised from eggs to adults. Observations on the immature life budgets of this species have revealed that, with a water temperature of 29.2± 0.2℃, the durations of eggs, larvae and pupae are 72–96 hr., 98–160 hr. and 48–82 hr., respectively; whereas 224–394 hr., 82–208 hr. and 76–216 hr., are for the different stages mentioned above when the water temperature reduced to 23.0± 1.7℃. The hatching rate, survival proportion of larvae, pupation and emergence rates are 90.2–96.0%, 80.7–96.5%, 89.3–96.2% and 74.0–96.0%, respectively, in accordance with the results of three duplications.

#48

SAND FLIES AND THEIR NATURAL LEPTOMONAD INFECTION IN IRAN. E. Javadian, M.A. Seyedi-Rashti (Medical Entomology Department, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran)

Forty three species of sand flies have so far been identified in Iran. Of them *P. Sergenti* is supposed to be the main vector of the anthroponotic type and *P. papatasi* to be the main vector of zoonotic type of cutaneous leishmaniasis.

On several occasions infection with promastigotes in *P. sergenti* have been found in Mashhad city and recently two cases in Esfahan city. Sand flies were caught from human dwelling and infection rate varied from 1 to 2%. Natural leptomonad infection in *P. papatasi* has been found in rural areas of Isfahan , Khuzistan province (Shush, Dezful, Ahwaz, Dehloran), Lotf-abad, Turkemansahra, Esferayan, and recently in Veramin (Abardege), Shah-rood and abarghou areas. Sand flies were caught from rodent and burrows infection rate varied from 0.5 to 20%. *P. caucasicus, P. mongolensis* and *P. ansarii* are as the other vectors of CL especially among rodents.

The vectors of VL is not known but on the basis of epidemiological evidence it seems *P. major* is the probable vector in most of the infected areas, although other phlebotomus belonging to Adlerius or larroussius groups may also play a role. In Khuzistan possibly *P. alexandri* has a role as a vector.

Finally the large-percentage of natural leptomonad infection of *S. sintoni* and also *S. clydei* thought to be related to lizard leishmaniasis.

#49

DELTAMETHIRN BATH OF DOMESTIC DOG IN THE PRENERNTION OF SANDFLY BITE. Xiong Guang-hua, Jin Chang-fa, Chen Xin-zhong et at. (Institute of Parasitic Disease, CAPM, Shanghai 20025, China)

Reports indicate that the incidence of dog visceral leishmaniasis is rather high in southern Gansu and northern Sichuan. It constituted an important route of human leishmaniasis infection through dog to man and both are inflicted. At present, dogs are raised in the endemic area and in the control of the disease, specific measure should be taken besides the killing of domestic dogs.

This is the first report in the experiment of water solution deltamethrin bath of dogs in the prevention of sandfliy bite.

An experiment of 15 dogs taking the insecticide bath was designated to test the deltamethrin residual insecticide effect. 1 month, 2 monthes and over 2 monthes after the bath, taking any bath of dog put in the mosquito net (dog was fixed in iron cage) with a number of unfed sandflies of Phlebotomus chinensis, from 23,00 to 7,00 hours. Relasing the dog, sandflies examined in the net their were near all found died, only a few living sandflies could be collected. However, all most of the died of poisoning within 1-4 hours. In the control groups, the most rate of died sandfly was only 14.9% within 24 hours.

The result was shown to give good kill sandflies of P. chinensis that the effect at least 2 monthes (over 70 days) in the local area.

Further experiment will be carried out to find the long residual effect of the insecticide lasts on dog body.

#50

OBSERVATION OF COMPARISON OF THE DEVELOPMENT OF SANDFLY PHLEBOTOMUS CHINENSIS IN DIFFERENT VERTICAL ALTITUDES

Xiong Guang-hua, Chen Xin-zhong, Jin Chang-fa et al.(Institute of Parasitic Diseases, CAPM, Shanghai 200025, China)

In June, 1988, engorged female Phlebotomus chinensis were collected from 2000m and 1400-1500m above sea level and bred at room temperature at altitude 1400m to observe the whole life cycle.

The period for the sandflies from altitude 2000m or more to complete the whole life cycle without diapause was found to be 48-58 d (average 56 d); while those from 1400-1500m was 43-56 d (average 50.8 d, $t=3.18$, $P<0.01$), showing significant difference between sandflies from different altitudes.

Repeat observation was done in Nanping, Sichuan in July, 1989. Sandflies collected from altitude 2000m or more were bred at constant temperature 25±1°C, and those collected from low altitude were bred at room temperature. A comparison was made of the development between these two batches of sandflies. When breeding at higher temperature, the sandflies from 2000m above sea level completed the life cycle in a shorter period of 50-65 d (average 58.3 d), and those from low sea level completed life cycle in 53-63 d (average 59 d, $t=0.24$, $P>0.05$), showing no significant difference.

Laboratory breeding of larvae in diapause at higher temperature (27±1°C) and illumination could not result in recovery of development, on the contrary, would cause gradual increase of mortality of these larvae. The proper way of breeding larvae in diapause is to keep them at room temperature and natural illumination.

#51

A STUDY ON BIOLOGICAL CHARACTER OF COCKROACH AND ITS CONTROL. Zhuangxing Ma (Shanxi Satellite Pest Control Technique Research Institute, Taiynan, 030012, China) Jingxia Cheng (Shanxi antiepidemic station Jianfa Li (Guixi Mouse-killing research Institute)

Cockroach (Dictyoptera, Blattidae) oviposits in egg case after mating for 10 days, and become nymph after 1 month. The adult emerges after 7-13 exuviations. They like to eat sweet and fermented food and live in shade, humid, warm places. They come out at night. 14 species of Cockroach have been found in China, which carrying with 40 species of disease germ and 7 species of parasitic worm. The control method: 1 To destroy the condition of existence for Cockroach. 2. To trap and kill them. 3. To kill them with chemical such as Chlorofos, Dichlorvos, and so on.

#52

A NEW DEVICE FOR AUTO-MONITORING THE FEEDING ACTIVITY OF COCKROACH, AND A STUDY ON THE OLFACTORY BEHAVIOUR OF PERIPLANETA AMERICANA. Gui-fan Dong, Sheng-ming Wu, Yan-de Dong(Institute of Microbiology and Epidemiology, 23(A) Qilizhang road, Fengtai, Beijing 100071, China)

A new device was designed for observing the feeding activities of cockroach, which receives informations with infrared sensors and stores up and processes the informations in a single board computer, and then prints out in a fixed format the results of feeding time and frequency. The olfactory behaviour of Periplaneta americana to some kinds of chemicals were studied. The cockroach showed a strong, positive taxis response to some of alcohols and carbohydrates, but negative to DMP and DEPA etc. The fact, that the olfactory receptors are existed on flagella of the antennae, was revealed by the tests that the cockroach kept on responding to the chemicals even with the flagella half excised, and gave no response at all when the whole flagella were cut down.

#53

ON THE FLEA FAUNA OF QINGHAI-XIZANG PLATEAU, CHINA. Cai Liyun, Zhan Xinru, Wu Wenzhen and Li Chao (Resarech Institute of Endemic Disease Control of Qinghai Province, Xining, Qinghai 811602, China)

Up to the present, 193 species and subspecies of fleas, belonging to 48 genera and 7 families, are found in the Qinghai-Xizang plateau. Among them, 159 species are Palaearctic accounting for 82.4%; 11 species is Oriental (5.7%); 17 species belong to the two regions mentioned above (9.8%); 5 species are cosmopolitan or widespread (3.1%). As far as known, 82 species and 4 genera (*Chinghai*, *Calceopsylla*, *Genoneopsylla* and *Mitchella*) of fleas may be considered as endemic forms of the Qinghai-Xizang Plateau.

The plateau is divided into five II-order regions (subregions). Namely the Loess-Plateau subregion, the Western-Desert subregion, the Qinghai-Zangnan subregion, the Qiantang-Plateau subregion and the Himalaya subregion. Each of the five subregions is characterized by representative species of fleas.

A list of flea species from Qinghai-Xizang plateau with their distributions and hosts is tabulated. Lastly, the relation between flea and its host fauna is preliminary discussed in this paper.

#54

ZOOGEOGRAPHICAL AFFILIATION OF THE MONGOLIAN FLEAS. Mathias Kiefer (Westendstr 79,8000 Munchen 2, Germany)

for the zoogeographical charakterisation we have used 160 species and subspecies of the Mongolian fleas. The flea fauna of Mongolia is divided into 16 groups considering areals of spreading. From this following four groups can be formed:

A. Groups 1-3, exclusively in Mongolia appearing fleas.
B. Groups 4, Takla-Makan-Gobi deserts fleas.
C. Groups 5-10, only in small areals appearing fleas.
D. Groups 11-16, big areals appearing fleas.

Groups A 1-3 center of spreading in Mongolia and adjoing areals.

#55
DEVELOPMENT OF FLEA FAUNA IN CENTRAL ASIA. Mathis Kiefer (Westendstr. 79,8000, Munchen 2, Germany), O.O. Szerhanov (Central Asian Antiplague Institut, Alma-Ata)

The present flea fauna in Central Asia contains approximately 180 species and subspecies. The estimated number of all species and subspecies, found in Central Asia, is around 200. These belong to 51 genera and subgenera. The Central Asian flea fauna complex is the largest in Paleoarkt behind the Middle Asian Moutain-complex.

The Central Asia flea complex is rather heterogeneous and it consists of the following zoogeographical units: the actual Central Asian, Nearctican Angarican/Siberican, Middle Asian, West European, Ethiopean and Oriental.

#56
MONSTROSITIES APPEARED IN A COLONY OF LEPTOPSYLLA SEGNIS REARING IN LABORATORY OVER A LONG PERIOD OF TIME. Dun-qing Wang (Laboratory of Medical Entomology, Fujian Medical College, Fuzhou 350004, China), Hau-rong Liao (Fujian Research Institute of Epidemic Diseases, Fuzhou 350001, China)

This paper reports the monstrosities of flea appeared in a colony of Leptopsylla segnis rearing in laboratory over a long period of time. Ten specimens have been illustrated. The abnormality of male movable process of clasper may be misidentified as a new species under normal condition.

#57
THE REASONS OF TERRITORIAL SPREADING OF FLEAS IN MONGOLIA. Mathias Kiefer (Westendstr. 79,8000 Munchen 2, Germany)

Solving this problems we have decided to compare the areals of spreading of fleas with the isotherms of the average annual temperature and isotherms of the average January and July temperature in concern the average annual fall out.

At 53 species and subspecies of fleas we were able to determine a dependance of spreading of some climatic factors.

The realised analysis follows, that for the northern species the average annual January and July temperature is decisine to determine the southern border of spreading. For the southern species the average annual falll out is decisine for the northern borders of spreading.

#58
COMPETITIVE COEXISTENCE AND COMPETITIVE EXCLUSION IN FLEAS (SIPHONAPTERA)

DUDICH; A.L.G., Institute of Forest Ecology, SAS 960 53 ZVOLEN, CZECHOSLOVAKIA

The distribution of oligo- and pleioxenous fleas of the Families Hystrichopsyllidae, Leptopsyllidae and Ceratophyllidae, parasites of small mammals (Insectivora,Rodentia) of deciduous and mixed forest geobiocenoses in the West Carpathians were analysed. Relations between couples or groups of closely re lated species were stated. These are following: - non competitive coexistence in sympatry by means of total host segregation (e.g. Palaeopsylla,sg.Euctenophthalmus); - probably non competitive coexistence with asynchronous praeimaginal development in synoxenia (Peromyscopsylla bidentata and fallax); - competitive coexistence of pleioxenous species by means of host substitution with high degree of host diversity (Ctenophthalmus, Rhadinopsylla, Hytrichopsylla) as well as abundance (e.g. Euctenophthalmus); - competitive exclusion of oligoxenous species with synchronous praeimaginal development (Peromyscopsylla silvatica vs. fallax) and in pleioxenous species with low diversity of host spectra in parapatry (some species of Genera Euctenophthalmus and Megabothris).

#59
A REPORT ON THE PREVALENT OF EUPROCTIS SIMILIS DERMATITIS OCCURED FIRST IN HEILONGJIANG PROVINCE. Chenggui Kang, Yan Yang, Boguang Xin (Sanitation and Anti-epidemic Station of Heilongjiang province, Harbin 150036, China)

The article first reported the epidemic condition of Euproctis similis dermatitis caused by aninsed pest Euproctis similis Dyar in northern Heilongjiang province. The type of the rash type, diagnostic basis, the ecology and preventive measures of the pests are also discussed.

#60
ENVIRONMENTAL MANAGEMENT OF VECTOR BORNE DISEASES WITH IMPLEMENTATION THROUGH AGRICULTURAL EXTENSION. Clifford E. Hoelscher (Texas A&M University, College Station, TX 77843) A.M. Zoobi (FAO, Rome, Italy)

A series of three international workshops have been conducted to promote the implementation of environmental management programs for the control of vector-borne diseases. The focus for these program planning workshops have explored the short and long-term objectives of agricultural extension strategies to reduce vectors. It has become evident that collaboration at all levels between public sectors of health, public education, industry and rural development need to be coordinated. The collaboration demanded requires a pooling of expertise from many disciplines found in institutions of higher education and international agencies. The presentation will focus on the present efforts being developed by a committee of scientists from FAO, WHO, UNEP and UNCHS to address major vector borne diseases. A publication will be available to demonstrate agency involvement, international participation and program strategies.

#61

A ANALYSIS OF FIUE—YEAR MUSCID SURUEYING RESULT IN DALIAN WEST GANJINGZI DISTRICT. Wang Wan (Dalian GanjingZi antiepdemic station, Ganjingzi ZhouJia Jie, Dalina, 116033). Jingxia Cheng (Shanxi antiopidemic station, 28shuangta xijie , Taiyuan 030012). Ahuangxing Ma (Shan xisanitationInsect—Killing research Institute; 19 Xiao nan guan, Tai Yuan 030012)

A analysis of Dalian Ganjingzi Five—year constant muscid surveying result, L(P)sericata(Mg) and M. stabulans (Fallen 1823)are major out of room, M. domestica domestica L is major in room. The others are B. melanura(Mg) L(p)cuprina(Wd, 1830). A grahami(Aldrich 1930). L(p) sericata(Mg) constitutrs 59. 38 percent, M. domestica domestica L constitute 17. 7 percent, M. stabulans (Fallen 1823) constitutes 10. 04 percent, the others constitute different. proportion. Muscid emerge earliest in last ten—day March, most emerge in following ten—dayjune, following ten—day july, and medicate ten—day Auguest, they disappear end of october. Country muscids emerge later ten—day than city 's. muscid index of peak time is higher 4—5 folds than city's. ratio of male muscids and female muscids geted is 1:3. 5, This article Intrudces effect testing result of control muscids.

#62

MOSQUITOES INVESTIGATION AND ITS CONTROL IN TAIYUAN CITY. Sumei Huo (Shanxi Hygienic & Anti-epidemic Station, Taiyuan 030012, China), Wan Wang (Hygienic & Anti-epidemic Station in Ganjing zi Region, Da Lian, 116033, China), Zhuangxing Ma (Shanxi Satellite Pest Control Technique Research Institute, Taiyuan, 030012 China)

Mosquitoes, eight species, three genera, exist in Taiyuan city, such as Anopheles sinensis, Culex pipiens pallens, Culex tritaeniorhynchus, Culex modestus, Culex vagans, Aedes vexans, Aedes dorsalis, Aedes koreicus. Culex pipiens pallens as the main species at yards in the city is 36.55% from the second ten-day period of May to the third ten-day period of October, but the serious period is August. Mosquito in suburbs is coming earlier and more than that in the city. The proportion of female to male is 9:1. There are 80% mosquitoes without sucking blood. The experiment of controlling them are showed in it.

OBSERVATIONS ON THE EFFECTS OF "JYJ" ON CONTROLLING MONOMORIUM PHARAONIS. Ji-qun yang, Xiao-man Yao, su-qin Xue, Yu-hua Han (Municipal Station of Hygiene and Epidemic Prevention, Beijing 100013, China), Jian Wu (Chinese Institute of Forestry Sciences, Beijing 100091, China)

Based on the ecological studies on Monomorium pharaonis in 1986-91, 43 baits and 26 prescriptions were designed and the "JYJ" was screened out to be the optimal one for controlling the ants' harmfulness. A practical application of the "JYJ" was made in 72 rooms where the harmfulness of ants was noisome. The baits were put in 128 selected sites with 0.1-0.3g of bait each site, and were taken back by the worker ants to their nest causing the death of the queen and other worker ants. A satisfactory result of wiping out all the ants could be expected 10 days after the application of "JYJ".

ENVIRONMENTAL MANAGEMENT FOR CONTROLLING MOSQUITOES AND FLIES IN SUMMER PALACE. Ji-qun yang (Municipal Station of Hygiene and Epidemic Prevention, Beijing 100013, China) Zhenpeng Su, Congcai Wang, Jinling Mao, Gaoming Li (Summer Palace Administrative Office, Beijing 100091, China)

A four-year study (1985-88) was undertaken on environmental management for controlling the breedings of mosquitoes and flies in Summer Palace. 16 breeding sites were selected for sampling where 5 species of mosquitoes were found, i.e. Culex pipiens pallens, C. tritaeniorhynchus, C. modestus, Anopheles sinensis and Aedes vexans. The reduction rates of 67.99% and 99.26% were obtained by 1986 and 1987, respectively, by means of pisciculture in ponds, the transformation of puddles to fishponds, the replacement of the old yachts by the covered new ones, and of the pavage of the paths with cobbles to eliminate the breeding sites. 15 species of flies including Musca domestica, Muscina stabulans, Lucilia sericata and Chrysomya megacephala, etc., were found and the reduction rates of 80.85% and 98.33% were obtained by 1987 and 1988, respectively, by means of the transformation of open-air garbage heaps to sealed cement garbage-transfer post and of uncovered manure pits to covered fermentation ponds to eradicate the majority of fly's breeding.

STUDIES ON THE COMPONENTS OF TRACE ELEMENTS AND MACROELEMEMTS IN HEMOLYMPH OF ANOPHELES ARTHROPOPHAGUS.(DIPTERA: CULICIDAE) Pei-hui Chen, Ying-hua Bian, Feng-wu Li, Shao-hui Zeng, Qiang Tian (Capital Institute of Medicine, Beijing 100054, China)

The elements in hemolymph of An. arthropophagus were determined by ICAP. There are 18 kinds of trace elements, and Fe, Zn, Cu, Mn, Cr, Mo, Co, Ni, V, Sr, B, Al, Ba, Zr, Cd, Pb, Ga, and Li, and 6 kinds of macroelements, i.e. Ca, Mg, K, Na, S, and P in mosquito hemolymph. The contents of all the macroelements and Fe are higher in newly emerged mosquitoes than in blood fed mosquitoes with striking significant differences between them. Comparing the elements in hemolymph between An. arthropophagus and An. sinensis. There are 14 kinds of elements in newly emerged mosquitoes with striking significant differences while 12 kinds of elements with striking significant differences and 3 kinds of elements with significant differences in blood fed mosquitoes. Comparing elements in hemolyph between An. arthropophagus and Ae. albopictus, there are 13 kinds of elements with striking significant differences and 1 kind of elements with significant difference in hemolymph of newly emerged mosquitoes, while in the blood fed mosquitoes there are 11 kinds of elements with striking significant differences and 2 kinds of elements with significant differences.

STUDIES ON FREE AMINO ACIDS IN HEMOLYMPH OF THREE SPECIES OF MOSQUITOES. Feng-wu Li et al.(Department of Parasitology, Capital Institute of Medicine, Beijing 100054, China)

Hemolymph was collected from female mosquitoes by centrifugation. The constituent of free amino acids in hemolymph was determined by an automatic amino acid analyzer. Comparing free amino acids in hemolymph of three species of mosquitoes, at emergence, we found there was remarkable quantitative difference in 14 kinds of amino acids between Anopheles sinensis and An. stephensi, 14 between An. sinensis and Aedes albopictus, 12 between An. stephensi and Ae.albopictus; At day 4 after taking rat blood meal, there was remarkable difference in 15 kinds of amino acids between An. sinensis and An. stephensi, 16 between An. sinensis and Ae. allbopictus at day 4 after taking rat blood meal and those taking chicken blood meal. The reason causing these changes are differences of species of mosquitoes and vertebrate host.

SYNTHESIS AND SPECIES SPECIFIC ATTRACTANCY OF AN OVIPOSITION ATTRACTANT PHEROMONE OF *CULEX PIPIENS QUINQUEFASCIATUS*. Jin-tong Zhang, Bao-lin Lu (Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, China), Xun Liu, and Jie Kong (Institute of Zoology, Academia Sinica, Beijing 100080, China)

The oviposition attractant pheromone of *Culex pipiens quinquefasciatus* was identified as *erythro*-6-acetoxy-5-hexadecanolide. A mixture of *erythro*- and *threo*- isomers of the lactone was synthesized by the aldol condensation from cyclopentanone and undecanal, producing 2-(1-hydroxyl undecyl-1-) cyclopentanone, then by the Baeyer-Villiger reaction and acetylation. The synthetic product was consisted of equal proportions of four isomers including the active *erythro*- (5R, 6S) and its enantiomer, and another two *threo*- enantiomers. Oviposition attractancy tests were made with the synthetic pheromone to four species / subspecies of mosquitoes. The synthetic pheromone showed an attractant effect to both *Cx. p. pallens* and *Cx. p. quinquefasciatus*, with a stronger effect to the former, and no effect to *Cx. tritaeniorhynchus* and *Aedes aegypti*, inferring that the pheromone is of species, but not genus, specificity.

COMPARASION BETWEEN VARIOUS FACTOR GROUPS CONDITIONING THE COLONIZATION OF HOUSE FLIES, *MUSCA DOMESTICA* L.(DIPTERA:MUSCIDAE) IN LABORATORY. Xiao-shun Jiang, Zong-mao YE, Yan-de Dong (Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, China)

The multi-levels orthogonal design and relevant statistical analyses were employed in evaluating the effects of various factors including temperature, humidity, juiciness in media, larvae density and the diet regimen for adults, on the colonization of house fly, *Musca domestica*, in laboratory at different developmental stages. Based on the theoretical optima obtained, with a consideration of practical experiences, a comprehensive condition, i.e. 25± 1℃ ,70± 5% RH, 130ml water / 100g larval medium, and 600 / 100g medium of larvae density,has herewith been recommended for rearing larvae, and the commercial dry milk or bean-milk powder could be used as adult diet.

EFFECTS OF TEMPERATURE, HUMIDITY AND DENSITY ON THE STANDARDIZED CULTIVATION OF *XENOPSYLLA CHEOPIS* (SIPHONAPTERA:PULICIDAE) IN LABORATORY. Hong-jie Zhang, Quan Liu, Yan-de Dong(Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, China).

The orthogonal design and relevant statistical analyses were employed to evaluate the effects of various factors including temperature, humidity and density on egg hatching, immatural development and cultivation qualities,involving the weights of both adults and larvae, adult longevity and fecundity, of *Xenopsylla cheopis* in laboratory. The results showed that the temperature acted as a major factor conditioning the immatural development and adult weight, the humidity was responsible mainly for egg hatching, immatural survivorship and adult longevity, and the density threw an effect principally on larval weight and adult fecundity. The theoretical optima obtained were: for egg hatching, 28℃,95% RH; for immature development,28℃,75%RH and 20 larvae / ml medium; for weights, 22℃,85%RH and 20 larvae / ml medium; for longevity, 22℃,85%RH and 60 larvae / ml medium; and for fecundity,28℃,85%RH and 20 larvae / ml medium. Based on the optima mentioned above, a comprehensive condition, i.e. 25℃,75%,85% or 90%RH (for larvae,adults and eggs, respectively) and a density of 20 larvae / ml medium,should be recommended for the cultivation of *X. cheopis* in laboratory.

EFFECTS OF TEMPRATURE AND HUMIDITY ON EGG HATCHING OF *PERIPLANETA ARMERICANA* L.(BLATTARIA:BLATTIDAE) Bei-si Li(Institute of Microbiology and Epidemiology,AMMS,Beijing 100071,China)

The effects were studied of temperature and humidity on the hatching rate of eggs in oothecae of *Periplaneta americana* reared in laboratory. The ranges of temperature studied were set at 22± 0.5℃,25± 0.5℃, and 28± 0.5℃, while of Relative humidity at 46± 2%, 75± 2% and 93± 2%, respectively. The results showed that a satisfactory outcome may be expected under a comprehensive condition of 28± 0.5 C and 75± 2% RH., with which the duration of eggs lasted 34.3 days,hatching rate was 92.35% for eggs and 71.4% for oothecae, and an average of 15.7 nymphes were hatched per ootheca.

OBSERVATION OF THE LIFE CYCLE OF BLATTELLA GERMANICA L.(BLATTARIA: PHYLLODROMIIDAE) Yun-jing Du, Yi Pan, Tong-jing Li, Shu-ping Chi (Millitary Medical School, the General Logistics Department of the PLA, Beijing 100071, China)

The life cycle of Blattella germanica has been fully observed under the normalized condition. The ootheca appears to be long ellipse in shape gripped at the apex of female abdomen and drops out after eggs hatching. 4-10 oothecae, 6.86 in average, could be laid per female in its whole life with less nymphs hatched from the ones followed the fifth. Averagely 39.03 nymphs could hatch from one ootheca. The hatching rate for eggs is 95.17% and for ootheca is 70.88%. The average duration for nymph development is 37.56 days, being divided into six instars with moulting five times and 55.98% individuals survived. The sex ratio for adults (female : male) is 1:0.828. The average life expectancy for female is 203.89 days, and for male is 157.82 days in normal, but only 14.29 and 8.50 days for female and male, respectively, if they were in starving. A life cycle will last 62.81 days. A pair of adults can theoretically reproduce 197972500 offsprings during a year.

OBSERVATION OF CYPERMETHRIN KILLING EFFECT ON HOUSE FLY. shu-yuan Zhang (institute of epidemiology and microbiology, chinese Academy of preventive medicine, Beijing 102206, China)

The observation on the 10% cypermethrin powder against house-fly was carried out in laboratory and in the field. The results showed that the doses of the agent at 2μg/per fly, the death rate of 24 hours was 96.7%, and the LD50 for femalefly was 0.0587μg/per-fly, and 0.025μg/per-fly for male. In the field trail, at the concentration of cypermethrin of 0.4-1.0g/m², its killing effect has been lasting for 75-90 days; in the meanwhile, hungingcage for observation of the rate on knock-down, the doses of the agent at 0.4g/per squire, it was 60% for one minute, 100% for 16 minutes, while the doses of the agent at 1g/per squire, it was 50% for 5 minutes, 100% for 14 minutes, and the death rate of 24 hours was 100%.

FORMULATIONS CONTAINING BPMC FOR CONTROLLING MOWQUITOS AND THEIR EFFICACY.Chen-xi Sun, Zun-lan Fan(Tianjin Health and Prevention Disease Centre, Tianjin 300011, China)

This paper reported some fomulations containing BPMC etc. (mosquito coil, mat and vaporizer mosquito liquid) and their efficacy against mosquito in laboratory studies (closed cyliner method). The results indicated that the mosquito coil containing 2-4% BPMC and synergist had a quick knock down effect as well as a strong killing activity. The mosquito mat made from a mixture of BPMC, Synergist and Pynamine-forte possessed higher effectiveness than the other mosquito mat containing 40-60 mg PYN-F only per mat. The vaporizer mosquito liquid containing BPMC, PYN-F and Synerdist, also had a quick knock down and high killing effect. The formulations containing suitable dose of BPMC have not only highly effective but also lower cost. But, the high quality of BPMC and Synergist is very important to the effectiveness of the products.

THE EFFICACY OF A NEW GROWTH REGULATOR ON MUSCA DOMESTICA VICINA Chen-xi Sun, Zun-lan Fan (Tianjin Health and Disease Prevention Centre. Tianjin 300011, China), Shi-xiong Wu, Jing-feng Chen (Institute for control of Agrochemicals, Ministry of Agriculture, Beijing 100026, China)

This paper reported the efficacy of cascade on adult housefly, its eggs and larvae(at second larval stage). The results showed that it had no killing efficacy on adult fly at dosage of 2 mg/m^3 by spray method. There was no difference between the egg hatch of the control group and the treated group, in which male and female are reared together and treated in 7 days after emergence. But there was evident difference between control and treated group, in which male and female are reared separately in 7 days after emergence. This indicated that cascade could control fly offsprings growth when unmated flies were treated. The larvae could not grow into pupa when they were reared in the diet containing 0.01, 0.05, 0.1, 0.2,0.4% cascade. The rate of pupation was decreased when larvae (at second larvae stage) were reared in diet containing 0.01, 0.05, 0.1% cascade. As the concentration of cascade was reduced, the rate of pupation was increased. But pupa could not grow into adult.

STUDIES OF CHINESE PLAGUE VECTORS IN INNER MONGOLIA: THE BLOOD SUCKING ABILITIES OF NOSOPSYLLUS LAEVICEPS KUZENKOVI (SIPHONAPTERA). Jun Liu, Shangjun Li, Yumei Zhang, Lianzhi Sun (Institute of Epidemic Disease Control, Inner Mongolia Autonomous Region, Huhhot 010031, China), Omar M. Amin (Department of Biological Sciences, University of Wisconsin-Parkside, Box 2000, Kenosha, Wisconsin 53141-2000, U. S. A.)

Nosopsyllus laeviceps Waqn . is an important flea vector in Inner Mongolia, transcaucasia, and the Volga Ural area of southeastern Russia. Controlled laboratory experiments using its natural gerbil host Meriones unguiculatus demonstrated a positive relationship between percent feeding and time allowed for feeding, particularly in female fleas. Increased blood imbibition corresponded with increased sucking time and was significantly higher in females than in males fed for ⩾ 10 minutes. The relationship between the frequency of feeding as well as the volume of blood imbibed and host species (4 host species were tested) was not statistically significant. Fleas fed better on active compared to confined M. unguiculatus. Findings were largely compatible with those reported for Soviet and other flea species also reared under controlled laboratory conditions.

A REVIEW OF THE EPIDEMIOLOGICAL SIGNIFICANCE OF PLAGUE NATURALLY INFECTED FLEAS IN INNER MONGOLIA AUTONOMOUS REGION. Liu Jiyou (Institute of Epidemic Disease Control, Huhehot 010031, Inner Mongolia Autonomous Region, China)

Fleas have been studied by corresponding with the control of plague in areas of Inner Mongolia Autonomous Region. In more than 30 years since mid 1950's, plague patients occured in these areas were mainly resulted form the bites of infected fleas. Of 118 species and subspecies (in 30 Genera, 7 families) of fleas, 26 species were found to be infected with plague in nature. The vector positions and effects of these naturally infected fleas, as well as the main vectors and secondary vectors in four types of plague of Inner Mongolia were primarily known through more than ten year's investigations. Cropsylla silantiewi is the main vector in the Mongolia martot plague foci. Citellophilus tesquorum is the main vectoer, and Neopsylla bidentatiformis, Xenopsylla cheopis, Frontopsylla luculenta and N. abagaitui are the secondary vectors in the suslik plague foci. Nosopsyllus laeviceps, X. conformis and N. pleskei are the main vectors and Rhadinopsylla insolita, R. tenella, R. dives, Coptopsylla lamellifer, Paradoxopsyllus kalabukhovi, X. skrjabini and N. galea are the secondary vectors in the gerbil plague foci. Amphipsylla primaris, Frontopsylla luculenta and N. pleskei are the main vectors and N. bidentatiformis is the secondary vectors in the vole plague foci. Other infected species apart from the above mentioned are occasional vectors.

PRELIMINARY STUDIES OF VITELLOGENESIS IN AUTOGENOUS MOSQUITO, AEDES TOGOI. Jian-xin Sun, Jing-xian Tan (Department of Parasitology, Second Military Medical University, Shanghai 200433, China)

The results of synthesizing vitellogenin(VG) by fat body cells(FBC) and VG concentration in heamolympy at different times during the vitellogenesis in autogenous mosquito, Aedes togoi, were first reported by using an immunohistochemistry and immunoelectrophoresis methods . It was found that the VG synthesis by FBC was initiated shortly after adult emergence, peaked at hour-24 and declined after hour-36, and that the VG concentration in heamolymph was detected at low level in early time post -emergence, and reached a peak at hour-36.

Compared with the results of an anautogenous strain in the same species, the processes of vitellogenesis in autogenous strain is differeces in initiating time and synthesiging VG capacity by FBC between two kinds of physiological strains.

THE EFFECTS OF TEMPERATURES AND HUMIDITIES ON THE DEVELOPMENT OF THE FLEA NOSOPSYLLUS LAEVICEPS KUZENKOVI. Jun Liu, Shangjun Li, Yumei Zhang, Lianzhi Sun (Institute of Epidemic Disease Control, Inner Mongolia Autonomous Region, Huhhot 010031, China)

The effects of temperatures and humidities on the development of Nosopsyllus laeviceps kuzenkovi were carried out at 11, 17, 23, 29, 35℃ (76% R. H.) and 32, 53, 76, 87, 100% R. H. (23℃) in the laboratory. The results showed that the duration from egg to adult decreased with the increasing of temperature as the temperatures ranged from 17-29℃ and the humidity was 76% R. H. 35℃ had a lethal effect on all the stages of pre-adult. The pre-adult stages developed very slowly when the temperature was 11℃. At 17, 23 and 29℃, the developmental rate from eggs to adults were 57%; 84% and 44% respectively. The flea could not complete the development of all the larval stages when the humidity was lower than 53% R. H., and all the larvae died of mould infection as the humidity was 100% R. H. The hatch rate, larval duration, adult size and longevity were affected by the humidity. The optimal temperature and humidity for N. l. kuzenkovi developing were about 23℃ and 87% R. H.

FIELD STUDY ON SEASONAL MIGRATION CULEX TRITAENIORHYNCHUS Jiquang Ming(Fengxian Medical Institute, Shanghai 201400, China), Yulin Tang, Zhixian Wang (Fengxian County Meteorological Station), Enying Zhang, Renlai Wang (Shanghai Second Medical University)

This Paper deals with the late autumn disappearance characteristics of Culex tritaeniorhynchus (C. t.) and its winter census as well as its early spring appearance in the coastal area, Fengxian County, Shanghai in consecutive 9 years of 1982—1990.

Characteristics of its late autumn disappearance and the result of winter census: 1. After the critical photoperiod, female adults emerged from the larvae and pupae collected in the fields were to be in diapaused as those bred in the laboratory. However, no adults in diapause were found in nature. 2. It appeared that C. t. could soar to the sky in September, as evidenced by 11 female adults caught at a height of 150—250 m above the ground. 3. C. t. in diapause could not survive low temperature as C. pipiens pallens did. 4. By searching the overwintering places, large number of C. pipiens pallens in diapause and a few Anopheles sinensis were found, but no C. t.

Early spring appearance: 1. Time of initial appearance varied in different years. The earliest was on 8 March, 1987, whereas it was 10 April, 1985. The difference between these two was 33 days. 2. Number of mosquitoes trapped also varied in different years. The largest was 1276 in 1990, while the smallest was only one both in 1984 and 1985. 3. Sudden appearance and sudden increase occurred with different intervals and duration in different years. 4. The above features of C. t. are in accord with the northward migration and landing pattern of seasonal migratory insects, that are, transported by southwest airflow and subsequent landing with the sinking airflow after the passing through of the front. 5. In some yeaes, the mosquito could also migrate northward and land together with the sinking airflow after the passing through of a strong southwest airflow and the front in February.

RESISTANCE DETERMINATION OF BLATTELLA GERMANICA DWELT IN TRAINS TO INSECTICIDES. Lan-fang Chai, Ling-xiu Xhang, and Guo-chen Li (Central Station of Epidemic Prevention, Zhengzhou Railway Bureau, Zhengzhou 450052, China)

F1 or F2 male individuals (1-2 week in age) of Blattella germanica, collected from 4 passenger trains in 1991 and reared in laboratory, were used for resistance determination to deltamethrin, cypermithrin, permethrin, vapona and propoxur. WHO Standard Measurement was followed and the resistance coefficient (R.C.) was calculated by KT50(w)/KT50(s). The values of R. C. ⩾3 were regarded as insecticide-endurance, while R. C. ⩾10 as resistance. The findings for the cockroaches to the 5 kinds of insecticides mentioned above were expressed in R. C. values as 2.68-3.97, 2. 65-4.32, 3.63-5.21, 2.22-5.22 and 0.99-1.32, respectively, revealing that the phenomenon of insecticide-redurance has emerged in the cockroach populations to all the insecticides tested except propoxur. The results provided a scientific basis for replacing the ineffective insecticides with the effective ones.

COMPARATIVE STUDIES ON PROTEINS OF THREE GEOGRAPHIC STRAINS OF ANOPHELES SINENSIS IN BEIJING, HUAIYIN AND FUZHOU. Min-jiang Pan, Bing-hui Ye (Department of Parasitology, Nanjing Medical College, Nanjing 210029, China)

The proteins of adults of Anopheles sinensis from Beijing, Huaiyin and Fuzhou were investigated by two dimensional chromatography. The results revealed: (1) The most chromatographic peaks were similar, but there were different peaks between strains. The Beijing strain contained of 315 peaks, Huaiyin strain gave 289 peaks, and Fuzhou strain gave 267 peaks. (2) It is quite interesting that the more the geographic distance between two strains, the more the different peaks. (3) Finally, the MW of the most proteins of three strains of mosquitoes were less than 94KD, more than 17.5KD, and pI ranged from 4 to 6 and 7 to 8.

DYNAMIC VARIATIONS OF FREE AMINO ACIDS IN THE HEMOLYMPH OF CULEX PIPIENS PALLENS (DIPTERA: CULICIDAE) DURING THE OVERWINTERING PERIOD. Tian-yun Su, Shou-zhi Su (Department of Parasitology, Henan Medical University, Zhengzhou 450052, China), Bing-hui Ye, Wei-xian Zhao (Department of Parasitology, Nanjing Medical College, Nanjing 210029, China).

The results of analysis on free amino acids (FAAs) in the hemolymph of Culex pipiens pallens during hibernation showed that 19, 18 and 18 kinds of FAAs were discovered in preoverwintering(A), overwintering(B) and postoverwintering(C) period respectively. Comparasions between (B) and (A) revealed that the concentrations of total FAAs and FAAs except cystine and proline reduced significantly in (B), and comparasions between (C) and (B) indicated that the concentrations of all FAAs and total FAAs increased significantly in (C), even the concentrations of aspartic acid, glumatic acid, alanine, cystine, proline and total FAAs exceeded their that in (A).

COMPARISONS AND ANALYSES OF HEALING EFFECT IN TREATING SYMPTOMS OF THE DEMODEX PRURITUS IN THE EXTERNAL AUDITORY CANAL WITH LINDANE CREAM. Ji-hong Ma (Department of parasitology, Natong Medical College, Jiangsu 226001, China)

In this paper the author examined 822 patients of all ranks suffering from th demodex pruritus in the external auditory canal with cellophane swab in Nantong City and treated 188 patients of positive demodex with the Lindane cream, Metronidazol+Vit B_6 and 4% alcoholic Boric acid. One week after using the author reexamined 173 patients, the demodex negative conversion rates were 98.39%, 94.44% and 70.18% respectively. The total effective rates were 88.71%, 70.37% and 31.58% respectively. In controlling symptoms of external auditory canal pruritus these three drugs show a difference of statistical significance in the killing of worms and amelicration of the clinical symptoms. $X^2=25.36$ and $X^2=45.76$, $p<0.01$. Lindane cream and Metronidazole+Vit B_6 were much better than 4% Boric acid alcohol. The result suggests that treating demodex external auditory pruritus with Lindane cream of Metronidazole+Vit B_6 is effective.

ULTRASTRUCTURE OF THE CHEMOSENSILLA IN ANTENNAL SENSORY PITS OF THE HOUSEFLY (*Musca domestica*). Hong—xiang Zhuge, Yang—chun Meng (Department of Parasitolgy, Suzhou Medical College, Suzhou 215007, China)

The present paper reports on the ultrastructure of antennal chemosensilla in female *Musca domestica*. The sensilla of out basal sensorium and posterior basal sensorium in 3rd segment were studied by scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The method of antenna section for SEM was set up in our laboratory. The posterior basal sensorium is full thin wall multiporous pitted sensilla (thin—wall MPS). The sensilla are 12.34±0.21 μm long and 2.02±0.23 μm diameter mid—hight wide. They have a wall 65.50±4.38 nm thick, and a pore density of 26.5±5.32 per μm^2. Just surface the pore may open into an enlarged circular chamber, the pore kettle, with a diameter of 0.1—0.2 μm. 15—20 pore tubules extend from the inner wall of the kettle(the diamter of the pore tubules is in the 8.96±0.59 nm range) into the underlying dendritic chamber. There is no dendritic sheath. The multiporous chemosensilla with deep longitudinal grooves(MPG) in the out basal sensorium are not numerous. These sensilla can be seen to be composed of 11—14 digitiform processes in SEM.

FAUNAL AND ECOLOGICAL STUDIES ON THE BLOOD SUCKING MIDGES ALONG THE BORDER LINE OF NORTHEAST CHINA. Guoping Liu, Zhen-fu Xiu, Li-hua Quan, Zhen-guang Tao, Xing-wang Zhang (Institute of Military Medical Sciences, Military District of Shenyang, Shenyang 110031, China)

During the 1980-1988, a faunal and ecological studies was carried out in 10 border areas, Mohe, Hulin county, etc. In this period, 36 species of midge were recorded, and of them 4 new species were identified and 5 new records to China. Ecological investigation on midges showed Culicoides obsoletus (35.7%) and C. punctatus (34.9%) were predominant species, and the composition of midges with different biotypes, places and seasons was different. This paper describes ecological properties of the Blood Sucking Midges.

RESEARCH FOR THE BREEDING METHOD AND THE LARVA FORAGES OF CULEX TRITAENIORHYNCHUS. Hui-min Wang, Cheng mo Lin, Yu-cun Cao (Shenyang Health and Anti Epidemic Station, Shenyang 110031, China)

The method of using the dried fish floss to manufacture 28 kinds of artificial forages of the larvae of Culex tritaeniorhynchus Giles is first reported by the writer. By the experiments, we have gotten six kinds of artificial forages that are suitable for the growth and the development of larvae of C. tritaeniorhynchus. The living rate of larvae is more than 79.9% with those forages, the reproducing period of the one generation is nine-ten days (egg-larva-pupa adult), the hatching tate of the rate is 99.4%. Up to now, the C. Tritaeniorhynchus in shenyang have been raised for 127 generations. For the first time, we found self-raising C. Modostus for 147 generations in the home and foreign.

LABORATORY STUDIES ON THE BIONOMICS OF AUTOGENOUS CULEX MODESTUS. Yu-cun Cao, Hui-min Wang, Cheng-mo Lin (Shenyang Health and Anti-Epidemic Station, Shenyang 110031, China)

This article reports the studies and observations on the developing period during each stage in its lifetime, ovarian development of adults, and autogenous rate of autogenous Culex modestus. Hatching rate of eggs was 95. 71%, egg stage was 1.1 days, larva stage was 12.5 days, pupa stage was 1.67 days, and the period from eclosion to oviposition was 4.2 days. 96 hours after emerging, the ovarian devetopment of females reaching Christopher's V was 84.88-94.72%. From the fourth generation to the one hundred and fifth generation, the total autogenous rate was 96. 37% . This article also discuss the autogenous charateristics of Culex modestus.

STUDIES TECHNIQUE OF ELIMINATING COCKROACHES IN DALIAN. Naiqing Liu, Cheng-jun (Directing Team of Eliminating Cockroaches of Dalian City, Liaoning 116021, China) Shou-wen Gao (Cottege of Military Medicine, Shengyang Mititary Area, Dalian, China)

Integrated control measures on environment control with propagating control were made as main measures. The opportune time and insect state of elimination cockroaches were promoted for the first time, so permanent measures of environment control were taken. As techniques were practiced, remarkable social benefits were obtained. Encroaching rate of cockroaches in residential areas decreased from 64.93 percent to 0. 48 percent and average density went down from 5.11 to 1.67 per room. Alive ootheca numbers in residential and public areas were zero. Benefit areas were 152.5 squre kilometers. The achievement was passed in examination of national experts team in late August 1989. The city was named as advanced city of eliminating cockroaches by The National Patriotic Health Campaign Committee.

A STUDY OF THE RELATOPM BETWEEM THE FLIES AND TREES IN LIVING AREAS. Busheng Liu, et al (Sanitary and Antiepidemic Team of Shenyang Military Area, Shenyang 110031, China)

In order to control flies more effectively, a study of the relation between the flies and trees was carried out in the living areas of Haikou, Guangzhou (Prov. Guangdong), Wuhan (Prov. Hubei), Shenyang from May to July, 1990. The investigation results were as follows; 1., 1531 trees belong to 49 species were examined, and of them, 17 species were found having flies. In these trees, the most important fly inhabiting trees were only 2—3 species in every areas, such as Pinus persica in Wuhan, Camellia Fakiensis in Guangzhou, ect. In the case of density, the nearer to building trees are, he higher fly s density in trees is. 2. 3298 specimens of flies belong to 43 species were collected, and of them, 10 species were prodomi-nant or subdominant. The investigation showed that the density and the species of fly in night was more than that in day, respectively. 3. In the synthetical measures controlling flies, we based on the key points gained in above investigation to treat focal trees nearer to building in living areas with insecticide and obtained satisfying effect.

INVESTIGATION ON SPECIES OF COCKROACHES IN FUSHUN CITY AND OBSERVATION ON THE ECOLOGICAL HABITS OF PERIPLANETA JAPANICA. Shi-min Zhu, Yun-chang Zhu, Hong-xue Li (Fushun Sanitation and Anti-epidemic Station, 113015, Liaoning, China)

Through investigation, three species of cockroaches were discovered in Fushun city. They are Periplaneta japanica, Periplaneta americana and Blattella germanica. The ecological habits of Periplaneta japanica, i. e. habits and active sites, growth and decline with seasons, reproductive ability, overwinter, etc. were observed.

STUDIES ON INTEGRATED CONGTROL OF COCKROACH ON A LARGE SCALE AT COUNTRYSIDE. Xijun Du, et al, (Beizhen Anti-epidemic and Sanitary Station, Liaoning 121300, China)

The paper reported the result and the characteristic of the integrated programme of controlling cockroach on a large scale of countryside in Beizhen county. On the basis of surveying on the population, ecology, habitat, distribution and infestation of cockroachs, the writers draw up a control programme suitable to local condition. As a result of conducting the programme effectively, the cockroach infested rate in dwelling room decreased sharply from 34.14% prior of control to 1. 17% . The average density decresed to 2.94 cockroach per room, comparing that with prior to the control which is 48.7 cockroach per room, therefore, that reaches the national standard of advanced area for control cockroach when these results were check up by Council of patriotic Health Movement of Liaoning Province on Oct. 21, 1990.

OBSERVATION ON THE EFFECTS OF K-OTHRINE AGAINST BLATTELLA GERMANICA. Yanan Zhang, Guowei Liu (Sanitation & Antiepidemic Station of LiaoYang Petrochemical Fibre Company, Liaoyang 111003, China)

The paper described the result of 0.03% K-othrine against Blattella germanica in the workshop of the PET filaments. The liquid medicine contained 0.03% K-Othrine was sprayed at different places and different areas in the workshop. The result of the experiment showed that the liquid medicine against B. germanica was at 98%-100% of killing rate and its effects could be lasted for 100 days.

AN OBSERVATION OF THE EGGS OF AEDES ALBOPICTUS AND AEDES AEGYPTI WITH SCANNING ELECTRON MICROSCOPE. Xun Yang, Zhi Qiu, Zhen-hai Wang (Dalian Health and Quarantine Bureau of China, Dalian 116001, China)

The scanning electron microscope was used on the observation of the eggs of Aedes albopictus and Aedes aegypti, as the difficulties of distinguishing the two species of eggs with optical microscope. The obvious differences were found in existance in the shell, the shell membrane and the spiracle of the eggs.

ENZYME VARIATION ANALYSIS OF FIVE GEOGRAPHIC POPULATIONS OF CULEX TRITAENIORHYNCHUS IN CHINA. Xun Yang (Dalian Health and Quarantine Bureau of China, Dalian 116001, China), Shu-yuan Zhang (Institute of Epidemiology and Microbiology, Beijing 102206, China)

Polyacrylamide gel electrophoresis was used to study the genetic variations of six isozymes (Acph., Aldox., Est., Ldh., Mdh. and Xdh.) representing ten structural gene loci of Culex tritaeniorhynchus collected from Fuzhou, Shanghai, Qingdao, Dalian and Beijing areas. The polymorphic variations were observed at the loci of Acph-2, Acph-3, Aldox, Est-2, and Est-3, respectively. Among them, significant geographic differences were existed in the allele frequencies of Acph-2, Acph-3 and Aldox. Genetic distance coefficient (Nei's) derived from allele frequency variation at ten allozymic loci was employed to evaluate the genetic differentiation of these strains. Genetic distance among these populations gave values between 0.0134-0.0592 with an average of 0.0259.

STUDIES OF USING MEDIUM QUANTITATVE ANALYSIS TO FORECAST PREVALENCE OF JAPANESE ENCEPHALITIS. Baolin Lu, Zhe Chen, Panqing Yu, Youyuan Zheng (Sanitary & Epidemiological Station of Donggou County, Liaoning 118300, China).

In the prevalence area of Japanese encephalitis of eastern Liaoning, use of ordinal and correct analysis method screened out two kinds of medium factors. To combine mathematic forecast model forecasts the intensity of prevalence of Japanese encephalitids by using quantitative analysis. 3 forecast index were used:

1. number of mosquito 2. constituent ratio 3. frequency

Through 11 year period (1981-1991), the results verified that the mean forecast error was 0.41/100,000 (P>0.05). The forecast results consist with the level of diseases of the entire area of Liaoning. The forecast results showed: Culex tritaeniorhynchus and Culex pipiens pallens exist a relation of quantity with the prevalence of Japanese encephalitis. The alteration of the number of population in a year was the main cause which lead to cyclical fluctuatious variation of the prevalence of Japanese encephalitis. The article raised a grade reference standard of prevalence intensity.

INVESTIGATION ON THE SPECIES OF GASTROPHILUS IN HORSE. Yu Han, Yi Chen, Yaohui Hu, Yifan, Luo, Wanjun Gu (Department of Animal Science, Jilin Agricultural University, Changchun, 130118, China)

The horse bots is caused by species of Gastrophilus which belongs to the oestus family and it is a chronic, emaciated and poisoning disease with high parasitic rate and harm to host. We investigated 93 horses in the slaughterhouse in Jilin Province and found 1625 third stage larvae. The larvae were identified and the results showed that 728 (44.8%) larvae belonged to G. intestinalis, 492(30.27%) belonged to G. haemorrhoidalis, 216 (13.29%) belonged to G. veterinus and 189(11.63%) belonged to G. pecorum. 17 in the 93 horses were found to be negtive and the parasitic rate was 81.72%. Some newly maggot forms were hatched in sand and then mature larvae became pupae and flies. Therefore, the species of Gastrophilus parasited in horse mainly were the larvae of G. intestinalis and the G. heamorrhoidalis in Jilin province.

THE PATHOGENESIS OF THE SECOND STAGE LARVAE OF GASTROPHILUS INTESTINALIS. Yu Han, Yi Chen, Zhensheng Yu, Yaohui Hu, Yifan Luo (Department of Animal Science, Jilin Agricultural University, Changchun, 130118, China)

The description on the morphology of the second stage larvae of G. intestinalis is race in literature. Based on Грунин(1953). The larvae separted from haematomata in foal's small intestine are identified as the second stage larvae of G. intestinalis.

No report concerning the death of foal, aged one month or so, caused by the second stage larvae of G. instestinalis has yet been reported in our country or abroad. From 1981-1988, autopsy of 5 foals died from the parasitization of the second stage larvae of G. instestinalis was carried out by the author. They all died of acute haemorrhagic enteritis. Therefore, the acute death of foal occured between May and June should be considered to be this disease.

OBSERVATIONS ON THE BIONOMICS AND THE MYIASIS OF IDIELLA TRIPARTITA (BIGOT, 1874). Ru-liu Yan (Parasitology Research Laboratory, Xiamen University, Xiamen, Fujian 361005, China), Yin-Kui Liu, Chun-he Zhang (Veterinary Station of Xianyou County, Fujian 351200, China)

The bionomics and the myiasis of Idiella tripartita (Diptera: Calliphoridae) have been reported in this paper. The eggs of the fly were laid in the dark cracks of the pigsties and hatched of 30℃, 20 hrs.' incubation. The larvae hid themselves in the dry straw, the porous clay and the dark corners of the pigsty during daytime, and sought for blood meal during night resulting in myiasis. An epidemiological survey was made from 1987 to 1989 covering 19 villages and towns of Xianyou County, Fujian Province. Among the 2277 pigs examined, an average infection rate of 73.95% was obtained with a highest rate of 86.80% in the piglet populations. The maggots and pupae of the blow fly can be year-round found in the pigsties with two peaks of seasonal abundence in June and Octobr, respectively. The longevity of the adult flies may last to 88 days in laboratory. In view of the preferrence of the chickens for the fly maggots, a combined rearing of both pigs and poultry may be a recommendable method for the blow fly control.

A STUDY ON THE ECOLOGICAL HABIT OF ARMIGERES'SUBALHATUS IN DAWA AREA OF THE MENGSHAN. Xi-zeng Zhang(Linyi Medical School,Shandong 276002,China)

Armigeres subalhatus was reported in Shandong Province for the first time in 1965 and found in five counties of south Shandong such as Pingyi, Linyi etc. in 1986. In Dawa area of the Mengshan Mountain A.S. imagines can be found in the first ten-day period of May, increasing in number in July, becoming the dominant species in mosquito colonies in Aug. and Sept., decreasing in number gradually in Oct., and disappearing gradually in Nov.. There are two tops of their activity and blood-sucking during the 24 hours of a day and a night, one at dusk and the other at dawn. When the temperature drops to 16° C and the below in the last ten-day period of Oct., wigglers begin their diapause time. The survival ratio reaches 90.5% after 12 hours freezing at -5° C and none survives a 60 hours freezing.When the temperature rises to 17° C and the above the overwintering larvae develop into imagines, which can suck blood only at the tempature above 17.5° C.

INVESTIGATION ON SEASONAL TRENDS OF COMMON FLY SPECIES IN KONGLIN AND THEIR MAIN LIVING HABITS. Fan—ji Kong,Shu—gong Zhao, Xin—Bei Huo,Xiang—liang Kong,Xiang—Li Kong(Pest Control Service of Qufu City,Shandong 273100,China).

The fly species in Konglin (Confucius Tomb) of Qufu and their main ecological habits were investigated from June of 1989 to May of 1990. 12903 flies were caught, belonging to 111 species of 55 genera of 9 famlies, of which *Ballardia* sp. and *Potamia* sp. were new species (identified by Fan Zi-de Prof., to be published). The species *Lispocephala erytrocera* CR.-D., 1830, *Atherigona biseta* Karl, 1939, and *paregle densibarbata* Fan are distributed limitedly in a few areas in other coutries. The dominantive species is *Lucilia illustris* (Meigen, 1826), others are *Chrysomyia megacephala* (Fab., 1784), *L. sericata* (Meigen, 1826), and *Muscina angustifrons* (Loew, 1858) in proper order (about 75% of the total number). Their seasonal trend appear single peak type, and there is a peak in July. All of the other fly species caught in Konglin can be briefly divided into 3 types: continuously, disconnected and a short time appearing. Based on the systemetic simulated studies of ecological habits of different types, measures of controlling the flies in Konglin are presented.

INVESTIGATION OF SPECIES AND HABITS ON BITING MIDGES IN QUFU CITY, SHANDONG, CHINA (DIPTERA: CERATOPOGONIDAE). Fan—ji Kong(Pest Control Service of Qufu City, Shandong 273100, China), Jian Xue (Jinan Military Medical Institute, Jinan 250014, China), Xiang—liang Kong(Qufu Public Health Bureau, Shandong 273100, China)

From April to October in 1990, an investigation on the species of blood sucking Ceratopogonidae and their ecological nature was made. 12 species of *Culicoides* were captured in all, among which *Culicoides konglinensis* sp. nov., *C. qufuensis* sp. nov. and *C. sacrilegus* sp. nov. were new species found in the investigation. The local dominantive species were *C. morisitai* (54.01%), while *C. punctatus*, *C. clavipalpis* and *C. konglinensis* sp. nov. were specific in the Konglin(Confucius Tomb). In a year, *Culicoides* began to move about in April, then their activities increased gradually, and reached the peak in September. In a day, there were no *Culicoides* moving about in the daytime. However, there were two peaks(dusk and dawn ones)in their nighttime activities, and the dusk peak was higher than the dawn one. In the multiplying nature of *Culicoides*, the detectable rate and the capture number of the young *Culicoides* in the water of holes in *Quercus acutissima* were higher than those in the water of the incense burners and hollows in the bases of tombstones in Konglin. However, in the residential areas the puddle water was mainly breeding site for midge. Therefore, it is emphasized that the breeding sites above should be eradicated in controlling of midges.

BREEDING HABITS AND CONTROL OF CULICOIDES CIRCUMSCRIPTUS KIEFF. (DIPTERA: CERATOPOGONIDAE) Xiang-rui Meng, Jian Xue, Xiao-min Yu (Jinan Military Medical Institute, Jinan 250014, China)

Culicoides circumscriptus Kieff. is a main blood suction species of biting midges on coastlands and islands in Shandong Province of China. Investigations on Sushan Island in 1982-1983 indicated that there were two breeding sites for this midge, i.e. water and moist-soil. The water breeding site was along seashore in range of 2-30m above full tide line. Area of breeding pool for the midge was smaller. Larvae were found in 27/75 pools with positive rate of 36.00%. The moist-soil breeding site was in rock chinks and the location was higher than that of water breeding site. Larvae in the moist-soil around the rhizome and were found in 6/61 sampls of moist-soil with positive rate of 9.84%. The integrated controlling practice emphasized on eradication of breeding sites obtained obvious effect. HCH (Hexachlorocylohexane) moist powder in grauze-bags thrown into the water of pools was effective for killing the larvae and the residual effect lasted for 3-4 months. Ultra-low volume (ULV) spraying of Sumithion 253 (Sumithion 20%, Dedecyl benzen 50% and α-Methylstyrene 30%) at 200-300ml/mu was successful in reducing the adult population of the midge. The reducing rates were 93-98% with residual effect about 10 days.

AN OBSERVATION OF CULICOIDES CIRCUMSCRIPTUS KIEFF. ON LIFE CYCLE (DIPTERA: CERATOPOGONIDAE). Jian Xue, Xiang-rui Meng, Xiao-min Yu (Jinan Military Medical Institute, Jinan 250014, China)

The life cycle of Culicoides circumscriptus Kieff. was observed in our laboratory in 1983. The testing strain was caught by man-trap in field on an island. Their eggs were collected with the moist filter paper. Newly laid eggs were light grey but darkened within a few hours. Hatching occured about 3-4 days after oviposition. The larvae were reared in "utensil contain water" and "keeping filter paper moist in utensil". During the initial stage of larva (1-2 instar), the whole body was transparent but the eyes were brown. The 3-4 instar body's color gradually got dark and the motions were active. The larva stage is much longger in "utensil contain water" than "keeping filter paper moist". The integument in newly pupaed specimen was colorless, gradually became dark, was afraid of light and liked to stay in dry place. The color of body in new-emergent adult midge is pale and soft. Flying began after about 15 minutes. Then adults were maintained with 10% glucose solution and females were given mice blood meal 3 days late. Two sexual adults can naturally mate with each other but the mating rate is only 9.00%. The results show that this midge can finish itslife cycle and has low mating rate under man rearing conditions.

AN INVESTIGATION ON THE COMPOSITION AND SEASONAL FLUCTUATION OF BLOODSUCKING MOSQUITOES AND MIDGES IN THE EAST COAST OF SHANDONG PROVINCE (INSECTA: DIPTERA). Jian Xue, Xiang-rui Meng, Jian-qi Jia(Jinan Military Medical Institute, Jinan 250014, China)

An investigation was made on the composition and the ecological habits of bloodsucking mosquitoes and midges during 1987-88 in the suburbs of Weihai C. and in the islands of Changshan, Kongdong and Liugong. 8 species out of 3 genera of mosquitoes, and 17 species out of 2 genera of midges including a new species, Leptoconops (L.) weihaiensis sp. nov., were obtained during the investigation. Among them Culex pipiens pallens took up the majority (79.99%) followed sequentially by Aedes togoi (8.22%) and Cx. tritaeniorhynchus (7.29%), whereas most of the midges were Culicoides circumscriptus (72.49%), and C. homotomus and C. punctatus were the secondary components (8.45% and 7.35%, respectivily). Mosquitoes and midges appeared in the coast areas in early and middle May, reached their peak populations by August and September, and disappeared in late October. They searched most actively for bloodmeal at dusk with a secondary peak at middle night. The factors which influenced the activities of the pests were in the order as illumination, wind speed, temperature and relative humidity.

THE EFFECT OF HEMOCYTE OF ANOPHELES STEPHENSI AND DIFLUOROMETHYLORNITHINE ON THE DEVELOPMENT AND MELANIZATION OF THE OOCYSTS OF PLASMODIUM YOELII.

Huang Fusheng, Wang Xingxiang (Department of Parasitology, The Third Military Medical College, Chongqing, 630038, China)

The ability of parasites to avoid immune recognition and/or inhibit or suppress the immune response is essential for their survival in the host. Microfilariae of Brugia pahangi acquire midgut material(s) of the mosquitoes on their surface during migration through the midgut and thereby avoid immune recognition upon entry into the hemocoel. Bitkowska et al. (1982) provided preliminary evidence that Trypanosoma cruzi suppresses the immune response of its vector, Triatoma infestans.

The development and melanization of the oocysts of Plasmodium yoelii were observed with transmission electron microscope after female mosquitoes were fed with sucrose solution or with difluoromethylornithine (DFMO) sucrose solution. The results indicated that there were few degenerated oocysts in control group. The encapsulated oocyst was seen. After female mosquitoes were fed with DFMO sucrose solution, the number of hemocytes increased around oocysts. The structured granules increased in the hemocytes and around oocysts. These findings suggest that hemocyte-mediated encapsulation reaction of oocysts was one of the important factors of melanization of oocysts.

A SCANNING ELECTRON MICROSCOPY OF MIROPHTHIRUS LIAE CHIN (ANOPURA: MIROPHTHIRIDAE) .

Tahsiung Chin, (Guiyang Medical College, Guiyang, Guizhou 550004, China)

THE HEAD The head is much broader than long. There is a longitudinal furrow in the middle of it. DPoCHS, DAcHS and DPHS are present on the hind margin of the frons. The occiput is not seen from above. The tip of the stylet is slightly expanded and scaly. The antennae have a huge basal segment and havy 2nd segment with a strong spur on the posterior margin. The last 3 segments are flagellate, small and upright. There are 11 peg organs at its lip. THE THORAX It is attached beneath the hind margin of the head. There is an arched sutrue running crosswise to divide the thorax into 2 parts. There are 6 minute setae along it. The notal pit is in the middle. the thoracic spiracles are at the anterior lateral angles of the fore part. The hind margin is minutely fringed. Ventrally it is covered entirely by a large skiffshaped thoracic sternal plate. The diminished forelegs are anterior to it, with the coxae close together, and covered completely by the head from above. The 2nd pair is the largest. All legs have small claw. THE ABDOMEN There are 2 minute setae situated postero-laterally to the spiracle on paratergites. All the abdominal segments and posterior margin of paratergites are fringed minutely.

PAEDERUS OF CAUSING DERMATITIS LINEARIS AND ANALYSIS ON THEIR BENEFICIAL AND HARMFUL EFFECTS ON MANKIND.

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Their are 20 species of Paederus capable of causing dermatitis linearis described in the world. The paper offers an index to the Chinese species and their distribution, proportion of the female to the sum total, the law of the adults; occurring by light attraction at night and the size of the body. The Paederus is beneficial to agriculture owing to their predation on numerous insects and pests, and their toxin is important in cancer research and cellular biology. Although these beetles can cause dermatitis linearis, the epidemics can be mitigated by simple precaution.

THE SPECIES AND SUBSPECIES OF THE GENUS SYNGENOPSYLLUS IN SOUTHWEST CHINA, WITH A CASE OF ATAVISM.

Kuei-chen Li (Department of Biology, Guiyang Medical College, Guiyang, Guizhou, 550001, China).

The genus Syngenopsyllus was establised by Traub in 1950 based on Ceratophyllus calceatus Rothschild, 1905 as the type. Specimens were collected from Malaya, Sumatra and Java. Four species and subspecies have been described and reported from southwest China, i.e. lüchunensis (Huang, 1981) from Yunnan, S. calceatus calceatus from Guizhou, S. c. remotus Li Xie & Pan, 1991 from Yunnan and Guang-xi and lui Li (in press) from E-mei, Sichuan. These records show that Syngenopsyllus is widely spread and extend far in southwest China, i.e. geographically from Indo-Malaya subregion to Indo-Chinese subregion of the Oriental region, about 29° N.

In the only female specimen of S. lui, there is a small electric bulb-like structure at the end of the long blind duct. It is presumed to be a rudimentary spermatheca, while the other one is normal with its normal spermathecal duct. The presence of such a structure in the genus Syngenopsyllus in the family Ceratophyllidae might be an occasional abnormality instead of being a significant character. The author believes that may be a case of ATAVISM.

A SCANNING ELECTRON MICROSCOPY STUDY OF TYPHLOMYOPHTHIRUS BIFOLIATUS CHIN (ANOPLURA: HAEMATOPINOIDIDAE).

Tahsiung Chin (Guiyang Medical College, Guiyang, Guizhou 550004, China)

THE HEAD The postfrontal suture is rather the posterior margin of frons, marked by the DPoCHS. Laterally along the sides of frons is the gena which appears dorsally to be a narrow stripe marked by the three DMHS and the long DPHS at the posterior angle. The occiput is distinct, attached to the frons beneath its hind margin. The sensillum at the tip of the terminal segment of antennae is like a flower with three or four concentric rings of "petals" surrounding eleven peg organs in the center which are also present between the layers of "petals". All the peg organs are truncate at tip and looked flexible. Ventrally the VPHS are situated at the anterior lateral angle of the gula. The tip of the stylet is simple, without teeth. THE THORAX The thoracic dorsum is covered by the lateral subcoxae or pleurite, meeting in the middle, leaving a longitudinal suture. Its posterior margin is fringed with minute teeth and marked by the DPTS and DMsS. Beneath and posterior to it is what may be the bow-shaped notum with a big hollow, the notal pit at the middle. THE ABDOMEN Dorsaly the first abdominal segment appears to be a bow-shaped stripe with a pair of short DCAS along its hind margin. Segments II and III are fused.

ON THE HOST SPECIFICITY AND THE ZOOGEOGRAPHY OF THE FLEAS IN GUIZHOU.

Kuei-chen Li (Department of Biology, Guiyang Medical College, Guiyang, Guizhou, 550001, China).

There are 47 species and subspecies of fleas belong to 27 genera and 6 families in Guizhou Province. Their hosts belong to 56 species and subspecies of mamals and birds, distributed in 7 orders, 22 families and 44 genera. Except 5 cosmopolitan fleas (i.e.P. irritans etc.), many of them are specific to their hosts or being rare, e.g.Araeopsylla elbeli from Taphlozous melanopogon; Thaumopsylla breviceps orientalis from Rousettus leschaulti; Syngenopsyllus calceatus calceatus from Callosciurus erythreus; Macrostylophora congjiangensis from Tamiops swinhoei; Paracerus brevimanubrium from Leopoldamys edwardsi; Typhlomyopsyllus cavaticus from Typhlomys cinereus etc.

Guizhou Province belongs to the Oriental Region, with the Southwest Mt. Subdistrict at its weastern boder, and the Western-Plateau subdistrict of the Central China district constitutes its main area. According to the flea fauna, the zoogeography of Guizhou is subdivided into 5 infra-subdistricts i.e. Western Plateau, Northern Canyon, Median-Hilly, Southern-eastern Hilly and South Low Mt. and Vally.

A TAXONOMIC STUDY OF EVACANTHIDAE FROM CHINA. Zizhong Li (Dept. Plant Protection, Guizhou Agricultural College, Guiyang 550025, China)

In the paper, the distribution, taxonomic survey, economic importance and external characters for genera and species of Evacanthidae from China are introduced and discussed. A key Chinese genera and species of Evacanthidae is given.

Totally 12 genera and 55 species of Evacanthidae in China are recorded in the paper, of which 3 genera and 20 species are new to science, 1 genus is reported as new record to China. The genera composition is as follows: Angustella Li including 2 species, Bundera Distant 4, Crinata Li et Wang 6, Convexana Li 3, Cunedda Distant 2, Dussana Distant 1, Evacanthus Le Peletier et Serville 25, Onukia Matsumura 8, Onukiades Ishihara 1, Paraonukia Ishihara 1, Signoretis Stal 1, Vangama Distant 1.

AN EXPERIMENTAL STUDY OF CAPACITY OF BLOCKING WITH YERSINIA PESTIS IN MARMOTA BAIBACINA STRAIN OF PULEX IRRITANS. Cun-ning Qia, Xiao-xue Zhang, Hong-Zhu Cao, Wan-wu Jiang Xiang Dai, Yu-ming Feng, Chi-ahon Huang (Xinjiang Institute for Epidemic Disease Control and Research, Urumqi 830002, China)

A total of 552 fleas of M. baibacina strain of Pulex irritans which were obtained from the grey marmot. M. baibacina, dying of plague septicaemia or from an artifical feeding apparatus for flea were quantitatively given blood meals containing Y. pestis, in order to cause them infected with Y. pestis. During the whole observation period, however, none of theses fleas was found to be blocked with a proventricular mass of Y. pestis. The infected fleas proved to be unable to play a role as vector in the process of Y. pestis transmission, indicating that fleas of this strain could not act as a significant vector in transmitting infection of plague. Furthermore, observations on the surviving time of Y. pestis in the proventricles and stomachs of the fleas showed that no causatiue agent of plague existed 12 days after infection. Cultures carried out for the presens of plague baicillus in the remainder of every batch of fleas after finishing the observation of blocking capacity also yielded negative results. Three possible factors responsible for the failure of this flea strain to form blocking with Y. pestis are suggested on the basis of physiological observations of the flea strain during the study period. It would be an urgent subject to make further studies on the characteristics of the biochemical enzymes in the stomach of this flea strain.

MORPHOLOGY OF FLEA PUPAE. Rui-yu Ye, Xin-ru Chen, Xin Yu (Institute for Endemic Disease Control and Research, Urumqi, Xinjiang 830002, China), Jin-tong Zhang (Institute of Microbiology and Epidemiology, AMMS, Beijing 100071, China)

Twenty species (or subspecies) of bare flea pupae were obtained on the cultivation of corresponding adult fleas and then by rearing the third instar larvae. The main structures of pupae and pupal features in different categories are described on the bases of observation of living individuals, mounted specimens, as well as the scanning electron microscopy. Micro-videotaping technique was also employed for some of the pupae. The flea pupae look like embryonic adults and pupal sex can be pointed out without difficulties. There exist generalities within, and diagnostic features between, different levels of taxonomic categories of pupae. They are the wing buds, the shape, amount and chaetotaxy of bristles on the cutiele and the shape of processes on segment 9 of abdomen in male pupae, etc.

A pair of wing buds, one of the most definite evidence that fleas originate from winged ancestors, exists on lateral mesothorax of all the observed 16 species of flea pupae belonging to Ceratophylloidea, but not on the 4 species of Pulicoidea. This may suggest that Pulicoidea might be in the much higher level of evolution than Ceratophylloidea.

OBSERVATION ON COPULATION AND REPRODUCTION OF MUSCA DOMESTICA. Shu yuan Sai, Guang-ye HU, Xiou-chun Chen, Shi-chang Zhou (Taishan Medical College, Taian, Shandong, 271000, China)

The adult of house flies (Musca domestica) begins to mate on the third day after emerging. The mating rate increases with the fly's age. Seventy-five percents of flies mate up to the eight day. The lower the temperature, the later the mating will be. Two groups of 30 adult couples were reared at the temperatures of 27-29° C, and 19-21° C, as a result, 13 and 7 couples of them had mated respectively by the third day, showing a significant difference between the two groups ($P<0.01$ by an X^2-test). Flies having better nutrition and exposing to light for a longer period of time mated earlier. The mating was accomplished between 9-12 AM with most of 15 couples observed. The average time for mating took about 27-25 minutes. Most of the females mated only once while the males could mate many times. They regained spermatozoa within two days for the next mating. The female oviposited about 8.6±5.6 times, averaging 653±351 eggs per head in its whole life. The number of eggs decreased with the number of oviposition times increased ($r=0.8834$ $P<0.01$). There existed a positive correlation between the total eggs aer produced by a female and its life span ($r=0.8280$ $P<0.01$). The longer the life span, the more the oviposition times, therefore a large number of eggs produced. For example, a female which lived for 68 days laid 1479 eggs, but the one which lived for 17 days gave only 201 eggs. Female flies did not oviposite in the period of 10-15 days before they died naturally. Dissection of the dead female revealed that their ovary canals become rope like and there were no growing follicles. The flies reared with powered milk laid the largest number of eggs. Animal's internal organs had most attraction for flies.

A REPORT OF RESEARCH ON FAMILY CULICIDAE (DIPTERA) EXPERT SYSTEM (FCUES). Tao Ni, Chun-song Wu, Shu-yao Liu, Chuan-sheng Chen, Chang-xiu Ning (Tongji Medical University, Wuhan, China, 430030)

The family Culicidae (Diptera) Expert System (FCUES) was a computer system, imitated computer mosquitology expert and expert of mosquito's taxonomy, which used intelligence tools of modern high function. The FCUES created could not only rapidly and exactly dealowith taxis appra, detection sarveillance and definition of vector species of mosquito, but also put forward effective control plans according to relational habits and characteristics and distribution fayna in order to control mosquito's, eliminate disease and protect people's health. The FCUES could be run in IBM personal computer XT or IBM PC/XT with 640x350 high resolution. All of the programmes, storaged in a hard disk drive, occupied the memory of 3660k bytes or so. They could be displayed in status of Chinese and the Western language and included 6 main modulars (or bases):

1. The Family Culicidae data inquiry modular containing 13 subbases;
2. Chinese mosquito species taxis key modular: It included taxis key of the known mosquitos totally 343 species or subspecies belong to 16 genera in China (Lu, 1988);
3. The mosquito's morphosis and taxis's charcteristic chart modular;
4. The mosquito's resources modular in different regions of China;
5. The explanation and study modular;
6. The FCUES system's managing, appending and maintaining modular;

The FCUES system's program diagrams were omited.

FORENSIC ENTOMOLOGY IS AN INDEPENDENT SCIENCE. Marchenko, Michail I. (Regional Bureau for Medico-legal Examination, St.Petersburg, 194291, USSR)

Forensic entomology emerged out of the needs of legal investigation practice and developed in contact with forensic medicine. The main tasks of forensic entomology are to determine post mortem interval, to establish the fact of cadaver displacement, to identify in insect body toxic substances that caused human death, to determine the place of origin of narcotic raw material as well as to deal with questions related to investigating the responsibility of officials for biological damage of materials, for breaching quarantine regulations, for violating technology of plants protection, for military application of insects.

Male Genitalia and the Phylogeny of the Pulicoidea
Tom Cheetham, Wilson College, Chambersburg, PA, USA

Comparative studies of the male genitalia provide the basis for a tentative sketch of the evolutionary history of the Pulicoidea. The division of the Pulicoidea into the Pulicidae and the Tungidae is not supported, and a single family, Pulicidae should be recognized. The major division, based on clasper anatomy, is between the Rhipimorpha and the Thermastromorpha. Members of the Thermastromorpha inhabit both the Old and the New Worlds, while the rhipimorphs are restricted to the Old World, and likely have a more recent, probably African, origin. The rhipimorphs include three subfamilies: Archaeopsyllinae, Xenopsyllinae and Moeopsyllinae. The thermastromorphs include four: Spilopsyllinae, Pulicinae, Tunginae and Hectopsyllinae. Neotunga, often considered annectant between the Tungidae and the Pulicidae is clearly echidnophagan and represents a case of convergent evolution. Xenopsylla is polyphyletic and should be broken into three separate genera. The aberrant Moeopsylla should be elevated to the rank of subfamily.

PROSPECTS FOR BIOLOGICAL CONTROL OF LARVAE OF VECTOR MOSQUITOES IN AN URBAN SITUATION. B. K. Tyagi (Regional Medical Research Centre (Desert), Post Box 122, New Pali Road, DMRC Complex, Jodhpur 342005, India)

There are innumerable constraints in controlling the larvae of vectot mosquitoes breeding particularly in man-made urban conditions. These mosquitoes, belonging to *Anopheles, Culex* and *Aedes* genera are responsible for transmitting serious diseases like malaria, lymphatic filariasis, Dengue and several other viral infections. The urban environment offers an unique "protective" breeding situation for vector propagation and very few methods including chemical and biological agents are acceptable to the community. Among the more reliable and sustainable biological methods, the use of larvivorous fishes, non-biting mosquito *Toxorhynchytes splendens,* the mermethid *Romanomermis* spp., certain fungi and bacteria has been often overeinphasized. Recently, however, certain species of odonata (e.g., *Bradinopyga geminata* and *Crocothemis servilia*) have also been found to have great potential in abating the larval density of *Aedes aegypti,* the vector of Dengue infection in south-eastern Asia. A review is presented for the known biological control agents, with special reference to insect predators who have been advocated as an adjunct to be used in an integrated vector control system in an urban set-up.

BIOCHEMICAL AND GENETIC MECHANISMS OF INSECTICIDE RESISTANCE AND IMPLICATIONS FOR RESISTANCE MANAGEMENT. Alan L. Devonshire (Department of Insecticides & Fungicides, AFRC, IACR, Rothamsted Experimental Station, Harpenden, Herts, AL5 2JQ, U.K.)

An understanding of the biochemical mechanisms underlying resistance in a particular species, and the cross-resistance patterns they confer, can help in deciding the most appropriate choice of insecticide. This knowledge together with molecular biological information on the genes responsible, can also be exploited to develop *in vitro* diagnostics for resistance, but these can only complement bioassays and not replace them. They will only detect particular resistance genes, a major limitation when used to monitor insect populations from the field, and one that will become more important as increasingly specific methods such as immunoassays and DNA diagnostics are developed. Their greatest impact is likely to be on studying the build-up of known resistance genes in defined insect populations as a means of developing and evaluating resistance management strategies.

MECHANISMS AND OCCURENCE OF GENE AMPLIFICATION AND ITS IMPLICATIONS IN INSECTICIDE RESISTANCE MANAGEMENT. C. Mouchès, N. Bensaadi, J.C. Salvado (Laboratoire d'Ecologie Moléculaire, Université de Pau et des Pays de l'Adour. 64000 Pau, France)

Gene amplification seems to be a widely occuring mechanism in insects from natural populations.

In some cases, the gene amplification process allow for the insect to counteract a strong environmental stress. For example, insecticide resistance in several insect species is associated with increased activity of a detoxifying enzyme, resulting from amplification of the corresponding structural gene. This is the case in *Culex* mosquitoes where high levels of organophosphate (OP)-resistance are due to the amplification of the esterase B genes. Characterization of the structure of the amplification unit responsible for OP-resistance in *C. pipiens quinquefasciatus* from California demonstrates that DNA sequences functionally related to mobile genetic elements are coamplified with the esterase B1 gene. In these cases, the dispersion and spreading of the amplified DNA unit in natural populations results obviously from the insecticide selection pressure.

However, very high levels of amplification of some other DNA sequences have occured apparently without such a strong selection pressure. We have identified and characterized several such DNA elements in many mosquitoes species. They may be 'selfish' entities, which have been repeatedly rising and falling during evolution.

ROLE OF ACETYLCHOLINESTERASE INSENSITIVITY IN INSECTICIDE-RESISTANT *HELIOTHIS VIRESCENS* AND ITS RECOGNITION BY BIOCHEMICAL TESTS. Thomas M. Brown, (Department of Entomology, Clemson University, Clemson, SC 29634, USA)

There are several possible biochemical mechanisms which can contribute to resistance to organophosphorus and carbamate insecticides. One mechanism is reduced sensitivity of the insecticide target molecule, the enzyme acetylcholinesterase found in the neuronal synapse. In adult heads of methyl parathion-resistant tobacco budworm, *Heliothis virescens,* this enzyme was approximately 20-fold less sensistive to methyl paraoxon or propoxur inhibiton. However, it was more sensistive to certain other inhibitors such as monocrotophos and the *N*-*n*-propyl derivative of carbaryl. This characteristic was use to discriminate among SS, RS and RR genotypes at this genetic locus, *AceIn.* This gene is located on chromosome 2 and is not linked to permethrin resistance in our strains. A rapid microtiter plate assay was used to determine the allele frequencies which have ranged from 6% to 89% in collections from cotton and tobacco. It appears that the resistant allele has declined since the widespread use of pyrethroid insecticides replacing acetylcholinesterase inhibitors.

ROLE OF ENZYME INDUCTION IN RESISTANCE MANAGEMENT. S. J. Yu (Department of Entomology & Nematology, University of Florida, Gainesville, FL 32611, U.S.A.)

Important detoxication enzymes such as microsomal oxidases, glutathione transferases and esterases were all induced by plant allelochemicals in phytophagous insects. Among the allelochemicals studied, monoterpenes (e.g., α-pinene), indoles (e.g., indole-3-carbinol), flavonoids (e.g., flavone), coumarins (e.g., xanthotoxin) and glucosinolates (e.g., sinigrin) were all inducers of these detoxication enzyme systems. The results suggest that the induction involves a common regulatory mechanism.

Numerous factors appear to influence induction in these insects. The microsomal oxidase in younger larvae was less inducible by host plants than in older larvae. Plant parts also affected induction. Corn leaves were most active compared with other aerial parts of corn in inducing the microsomal oxidase. Moreover, crucifers and umbellifers were generally better inducers of glutathione transferase than other plant families. Differences in enzyme inducibility were also observed among species and strains of insects.

Enzyme induction and insecticide resistance are related since insects with induced enzymes are often more tolerant of insecticides. In this respect, field manipulations such as the treatment of less inducible stage of insects, use of non-inductive plant varieties through genetic engineering and crop rotation may be important considerations for managing insecticide resistance.

ROLE OF P450 MONOOXYGENASES IN RESISTANCE AND THE BIOCHEMICAL BASIS FOR ITS MANAGEMENT. Jeffrey G. Scott (Department of Entomology, Comstock Hall, Cornell University, Ithaca, NY 14583 U.S.A.)

We have recently purified a cytochrome P450, termed P450lpr, from the multi-resistant LPR strain of house fly (Musca domestica) that has very high levels of resistance to pyrethroid insecticides. A polyclonal antiserum was raised, shown to be specific for P450lpr and used to characterize this P450. P450lpr was expressed at highest levels in adult LPR house flies, compared to larvae or pupae, and was found in both sexes. P450lpr was found at 44-fold higher levels in LPR than in susceptible flies. A single immuno-reactive band in denaturing gel electrophoresis, corresponding to P450lpr, was found in all house fly strains tested, with higher levels being found in resistant compared to susceptible strains. P450lpr was found in several abdominal tissues suggesting resistance is not due to tissue specific expression of P450lpr. Genetic analysis revealed that the overexpression of P450lpr in the LPR strain is a polygenic trait. Anti-P450lpr inhibited P450 monooxygenase dependent in vitro deltamethrin metabolism in LPR microsomes indicating that P450lpr is involved in P450 monooxygenase dependent pyrethroid resistance. Characterization of the regulation and substrate specificity of P450lpr is offering new insights into how monooxygenase-mediated resistance might be managed.

THE SEARCH FOR REALISM IN SIMULATIONS OF RESISTANCE MANAGEMENT METHODS IN MOSQUITOES. C.F. Curtis (London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, U.K.)

Two unrelated pesticides might be used:

1. as a rotation, with switches between them made
   (a) when resistance testing shows that these are necessary or possible;
   (b) frequently and according to a pre-arranged scheme;
2. as a mixture.

Simple computer simulations show that 1(b) would only be superior to 1(a) if modifier genes cause co-adaptation of the fitness of resistance genes or if there are practical reasons for favouring a short term rotation. Simulations suggest that mixtures would be superior to rotations if each pesticide kills a very large proportion of exposed individuals with susceptibility genes for the compound concerned.

One may be justifiably sceptical about the realism of simple computer models. We are therefore testing mixtures and rotations on impregnated mosquito netting which mated females Anopheles mosquitoes are "challenged" to penetrate to blood feed. Those which succeed constitute the parents of the next generation. The pesticides tested in this way include pyrethroids, organophosphates and an insect growth regulator with an adult sterilising effect.

EVIDENCE FOR DELAYING THE EVOLUTION OF RESISTANCE BY MOSAIC APPLICATION OR MOSAIC ROTATION OF INSECTICIDES. Zhen-hua Tang, Qi-fa Hau, Pei-jun Zhuang (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China)

For appraising effect of the evolution of resistance by mosaic application, we used a synthetic population of Culex pipiens pallens as model insect and simulated the effect in the lab. The simulation results showed (1) that mosaic control with unrelated insecticides could retard resistance development in given conditions; (2) that it was extremely effective for monofactorical but little for potygenic.

The above strategy, however, is not suitable to these pests such as aphids which reproduce by means of parthenogeuesis. Mosaic rotation with unrelated insecticides in different sectors has been used to control vegetable aphids such as the mustard aphid (Lipaphis erysimi pseudobrassicae), the peach-potato aphid (Myzus persicae), and the willow aphid (Cavariella salicicola) in Shanghai since 1985. Based on the bioassay and estimation of α-NA esterase activity in single aphid, mosaic rotation of dimethoate and fenvalerate can delay the ouset of insecticide resistance in the above three species of vegetable aphids when compared with the continued use of dimethoate, followed by the continued use of the fenvalerate to the point of where resistance impaired control.

BACILLUS THURINGIENSIS AND B.SPHAERICUS: THEIR POTENTIAL ROLE IN RESISTANCE MANAGEMENT AND RESISTANCE IMPLICATIONS. George P. Georghiou (Department of Entomology, University of California, Riverside, CA. 92521, USA.)

The relative ease with which insects have developed resistance to various classes of synthetic insecticides has raised concerns that similarly high propensity for resistance may also exist toward the insecticidal crystal proteins (ICPs) that are produced by Bacillus thuringiensis (BT), B. sphaericus (BS) and other related bacteria. While the record to date indicates that some resistance toward single ICP toxins may be expected when these are used individually, it also suggests that certain properties of these biopesticides may be important deterrents of resistance. These properties include a relatively high degree of specificity of toxic action of different ICPs, multi-toxin involvement in the intoxication process, feasibility of custom-synthesis of ICP combinations through genetic transformation or recombination, environmental instability of ICPs, and lack of dominance of the resistance character. Understanding these factors presents opportunities for forestalling the development of resistance to biopesticides thus providing much needed support to integrated pest management.

This paper presents a comparative analysis of factors that influence the evolution of resistance to ICPs and conventional insecticides. Research on BT and BS regarding the rate of development of resistance in Culex quinquefasciatus, cross-resistance, interactions with conventional insecticides, inheritance, and stability of resistance are also presented.

RISK ASSESSMENT OF PYRETHROID RESISTANCE FOR CONTROL OF THE HOUSEFLY IN TOKYO BAY DUMPING SITE
Shono,T.(Inst.Agr.& Forest.,Univ.Tsukuba), Mihara,M., Tomita,T. and Kono,Y.(Dept.Med.Entomol.,Natl.Inst.Health)

The housefly in the Tokyo bay dumping site, where chemical control against the housefly has been continued for long years, showed high resistance to the most of organophosphorus insecticides. As for pyrethroids, tetramethrin was introduced as a mixture of fenitrothion in 1980, and permethrin as an adultcide in 1988. Since 1985, the control by pyrethroids has been programmed according to the results of monitoring both insecticide susceptibility and gene frequency of the kdr. The gene was not detected in 1985.

The LD_{50}s against tetramethrin and permethrin in 1991 were 1.86ug/fly and 0.076ug/fly, respectively, and these values show that the population still remained susceptible level. However, the kdr (0.9%) was first identified in 1988 due to tetramethrin spraying. A total of 4 generations' exposure to permethrin during 3 years after 1988 raised the gene frequency to 6.5%, and to 11.5% by further spraying during 1991. Relative fitness of both kdr/+ and +/+ genotypes was estimated at 0.02 or less under the selection pressure with permethrin throughout a generation, based on the above results.

We simulated that the resistance in the population will quickly reach to the unsuccessful level of control by pyrethroids unless the program is changed to spot uses of the insecticides.

NINE YEARS OF ORGANISED PYRETHROID RESISTANCE MANAGEMENT IN *HELIOTHIS ARMIGERA* IN AUSTRALIA : WHAT HAS BEEN LEARNED?

Neil W. Forrester (NSW Agriculture, Agricultural Research Station, Narrabri, New South Wales, 2390. Australia).

The first pyrethroid failures against *Heliothis armigera* in Australia occurred in Emerald, central Queensland in January 1983. A voluntary Insecticide Resistance Management (IRM) Strategy was quickly formulated and implemented the following season. The Strategy was based on rotation of unrelated chemical groups, with the pyrethroids being restricted to a 42 day window (one generation) in the middle of the season. The impact of this Strategy and various management practices were determined by screening larvae, reared from field collected eggs, with discriminating doses of fenvalerate, endosulfan and fenvalerate/piperonyl butoxide (Pbo) mix.

It was found that pyrethroid resistance responds rapidly to selection pressure during and immediately after the pyrethroid window (due to moth and larval selection, respectively) but then declines slowly during the non-use period. However, the net effect is a slow but gradual increase in pyrethroid resistance over time. This is probably due to lack of any detectable biological disadvantage in pyrethroid resistant individuals, resulting in an increasingly contaminated refugia and a consequent decreasing effectiveness of the refugia as a source for dilution by susceptibles. On the other hand, endosulfan resistance has proved much easier to manage but the reasons for this are still unclear.

Monitoring of pyrethroid resistance mechanisms has indicated a change over time to an increased importance of the metabolic detoxification mechanism based on monooxygenases (ie. suppressible by Pbo). Consequently Pbo has been used as a commercial pyrethroid synergist for the past two seasons. Pbo is recommended to be used only once per season to avoid resistance development and other synergists are being researched with an aim to develop a synergist rotation scheme within the present insecticide rotation scheme.

Destruction of diapause pupae by cultivation of cotton stubble over winter, has proven to be a key resistance countermeasure in the Australian IRM Strategy.

MONITORING TECHNIQUES AND COUNTERMEASURES FOR PYRETHROID RESISTANCE IN HELIOTHIS ARMIGERA IN CHINA. Jinliang Shen, Jianguo Tan, Fujie Tan, Ziping You(Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, CHINA)

The resistance to pyrethroids was detected from 1983 to 1990 in 21 colonies of cotton bollworm, Heliothis armigera (Hubner), collected from six provinces, such as Jiangsu, Shandong, Hebei, Anhui and Xingjiang Province in China. There was no evident resistance until 1989 when it was found that low level of resistance in colony of Huangfaqu Farm Experiment Station of Henan Province (RR: 7 fold to Deltamethrin and 4.8-7 fold to Fenvalerate), low to moderate level resistance (RR: 11.1 fold and 7.7 fold, respectively) in colony of Ling County of Shandong Province), moderate level resistance (RR: 23 fold and 20-33.3 fold, respectively) in colony of Liaocheng district of Shandong Province . In 1990, the resistance level to Fenvalerate in colonies of Yanggu County and Guanxian County (Shandong Province) increased to 88.9 fold and 55.1 fold.

Results tests with discriminating dosages (LD_{99}'s) of Deltamethrin and Fenvalerate in all colonies showed that the proportion of resistant individuals increased with the level of resistance. The proportion was less than 10% in susceptible colony, 15-16 in low-moderate resistance colony and 70-80% in high resistance colony.

Studies on resistance mechanism indicated that the detoxification of MFO was one of the factors which caused resistance to pyrethroids in cotton bollworm. The resistance management program is suggested to prevent the further development of pyrethroid resistance in this pest in China.

BIOLOGICAL AND BIOCHEMICAL CHARACTERISTICS IN INSECTICIDE-RESISTANT DIAMONDBACK MOTH OF VALUE IN RESISTANCE MANAGEMENT. Tadashi Miyata (Faculty of Agriculture, Nagoya University, Chikusa, Nagoya 464-01, Japan)

Diamondback moth, Plutella xylostella (L.) is an important and cosmopolitan pest of crucifer crops. It is acknowledged that the diamondback moth has a long history of resistance to various kinds of insecticides and also shows resistance to newly introduced insecticides within a short period.

The release of insecticidal selection pressure often results in a reduction in insecticide-resistance following several generations of insecticide-free condition. This indicates that the resistant-diamondback moth has disadvantages in biological aspects comparing susceptible one. Insecticide-resistance of diamondback moth is caused by the following mechanisms such as reduced sensitivity of the target site, increased degradation activity of insecticide and reduced penetration of insecticide through the cuticle. How to incorporate these biological and biochemical characteristics in the insecticide-resistant diamondback moth into the resistance management will be discussed.

DIAMONDBACK MOTH RESISTANCE TO INSECTICIDES: COPING WITH DETOXICATION MECHANISMS. Chih-Ning Sun, Fang-Ming Chiang, Ya-Huei Liu (Department of Entomology, National Chung-Hsing University, Taichung, Taiwan 40227, China).

Diamondback moth, *Plutella xylostella* L., has become the most notorious insect pest of cruciferous vegetables throughout the world, mainly due to its extraordinary capacity to develop resistance rapidly to almost all synthetic insecticides as well as the microbial control agent, *Bacillus thuringiensis*. Enhanced detoxication mediated by microsomal P450-dependent monooxygenases (P450) and glutathione S-transferases (GST) has been found as the major mechanisms of resistance to benzoylphenyl ureas, pyrethroids and some organophosphorus insecticides in this insect. While different P450 isozymes are found to be involved in the detoxication of benzoylphenyl ureas and pyrethroids, there is no indication as to how many P450 isozymes diamondback moth larvae actually possess. Two groups of GST with distinct substrate preferences have been identified: one that degrades parathion and methyl parathion, and the other that conjugates model substrates, such as dichloronitrobenzene. The possible management of resistance by coping with these detoxication mechanisms will be discussed.

INSECTICIDE RESISTANCE OF COTTON APHID IN NORTH CHINA. Sun Yunqin, Feng Guolei, Yuan Jiagul, Gong Kunyuan. (Institute of Zoology, Academia Sinica, Beijing, China)

Cotton aphid (Aphis gossypii Glover)is one of the pests that attack seriously cotton during the seedling stage in the wide cotton areas in North China. There are roughly 4 stages of chemical control of cotton aphid in northern areas:

1. Organophosphorus insecticides such as parathion and systox were used in practice for chemical control from 1953 to 1963. During this period the concentration and the number of sprays were increasing year after year. The spray of systox and parathion on foliage was of no effect ot control aphids any more after 1963.

2. In the early 1980's, highly effective pyrethorid pesticides such as de-cis, sumicidin were largely imported into China. When first used in 1980, 2.5% de-cis emulsion was diluted in the ratio from 1:10000 to 1:12000. However in 1985, the resistance of cotton aphid to pyrethorids increased by 171 times in general, 3320 times in some cotton fields and much higher in specific fields by comparison on LD_{50}.

3. Based on the research on resistance mechanisms, the strategies were being sought for prevention or delay the development of resistance cotton aphid. Experiments showed that SV_1(O,O-diethyl, O-phenyl phosphorothionate) was particularly synergistic organophosphorus or pyrethorids pesticides. From 1986 to 1990 the factory to which we introduced SV_1 had produced 1787 tons synergistic organophosphorus and pyrethorids emulsion and 3574 tons of preparation mixtures. SV_1 had played an excellent role in delaying the resistance of cotton aphid to insecticides. Unfortunately, since 1989 even the synergistic pyrethorids have been unable to control the increasing numbers of resistant cotton aphids.

4. New pesticides superior to current pyrethorid insecticides seemed unlikely to be obtained in a short period of time. At present, methomyl and fosthietan still have effective toxicity against aphids and a variety of preparation mixtures appeared in China. The most promising way to retard resistance is to reduce pesticide use by integrating pesticides with other controls.

COTTON APHID: PREDICTION AND AVOIDANCE OF RESISTANCE TO PYRETHROID INSECTIDES. Zhaojun Han, Yinchang Wang, Fujie Tan, Ziping You (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China)

Studies have been carried out with laboratory. and field strains of cotton aphids to search for the methods of prediction and avoidance of pyrethroid resistance onset. The results are briefly summarized as follows: 1) The Kdr was found to be the main mechanism for cotton aphid resistance to pyrethroids. MFO and esterases also taked some part in the detoxication. The resistant cotton aphids exhibited strong cross-resistance to all pyrethroids tested, but little to organophosphates and carbamates. 2) The resistance was demonstrated to be regulated by a single recessive gene. Insecticide selection of the homozygotes was the main cause for the resistance development, and the parthenogenesis of these homozygotes could accelerate resistance outbreaking in the growing season. 3) Pyrethroid resistance did not reduce the fitness of cotton aphids. The sensitivity recovering mainly depended on the reversal mutation of the resistance gene. Otherwise, the sensitive immigrants could delay the resistance development of field populations in the growing season. Finally, based on a combination of these results, controling experience and some theoretical considerations, a computor programme was established for prediction of pyrethroid resistance in cotton aphid. And some strategies for avoidance of resistance were also proposed. They have been proved useful, but futher research to validate them is still required.

1.OVERTURE TO RESEARCH ON THE INSECT RESURGENCE. Tetsuo Saito(Faculty of Agriculture,Nagoya University Chikusa,Nagoya 464,Japan)

In spite of good initial kill at the time of treatment of insecticide,an appearance of a tremendous increase of the target insect pest population or other insect species which are present only in small numbers at the time of insecticide treatment is called resurgence of the insect pests.This phenomenon is explained by the following hypotheses.

(1)The reduction of natural enemies by the insecticide.
(2)Increase in the resurce(plant growth) for the pest cause by temporary low population of insect pests after insecticide treatment.
(3)Change of the distribution pattern of the insect pest from contagiou to random by insufficient insecticide treatment.
(4)Increase of reproductive rate stimulated by insecticide treatment.

These factors often integrate and occur together causing the resurgence of the insect pest in the field with weather conditions being influential on the insect pest population growth after an application of a insecticide.The research on the insect resurgence,mechanism and solution are needed.

PROBLEM OF RESURGENCE OF RICE INSECT PESTS AND ITS POSSIBLE SOLUTION. Dexiang Gu (Institute of Entomology, Zhongshan University, Guangzhou, 510275, China)

Owing to the changes in cropping system and inappropriate use of pesticides from 1960s to 1970s in China, the rice pests had been induced to develop resistance to pesticides and many natural enemies of the pests had been killed and function of natural enemies were greatly suppressed. As a result, the damage caused by pests increased yearly and resurgence of some species of insect pests often occurred, that prompted the proposal of integrated control of rice pests. Since 1980s, the targets of control have included plant diseases, insect pests, mice and weeds and the strategy had been formulated as "agricultural control as foundation, conservation and utilization of natural enemies and rational use of chemical pesticides." The principal measures included:(1) use of resistant varieties of rice plant against plant diseases and insect pests; (2) use of cultivated control measures; and (3) use of selective chemical insecticides. In 1980s the extention of these measures for controlling rice pests has convered 5,500,000 ha in China, and the resurgence of insect pests in paddy fields has rarely occurred in extention areas.

RESURGENCE OF THRIPS PALMI, AS RELATED TO DESTRUCTION OF ITS NATURAL ENEMIES. Yoshimi Hirose, Hiroshi Kajita, Masami Takagi and Eiko Tagashira (Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Insecticides are frequently sprayed to control Thrips palmi, a serious pest of vegetables in Japan. Field experiments demonstrate that resurgence of T. palmi on eggplant is induced by different types of insecticides, such as cypermethrin, sulprofos, fenthion and DMTP, and that this resurgence is due to destruction of Orius sp., an important natural enemy of the thrips. The resurgence of T. palmi by spraying DMTP is also due to elimination of competitive pests, Aphis gossypii and Tetranychus kanzawai on eggplant. Among the four insecticides mentioned above, cypermethrin has the most detrimental effect on Orius sp. because this insecticide suppresses the predator even three weeks after a cessation of its frequent applications. We conclude that the problem of T. palmi resurgence could be solved by reducing the frequency of insecticide applications to control this pest and preparing an integrated program to control other pests on the same crop.

THE MECHANISM OF RESURGENCE OF THE DIAMONDBACK MOTH. Hisashi Nemoto (Saitama Horticultural Experiment Station, Rokumanbu, Kuki, Saitama 346, Japan)

In 1981, at Saitama Horticultural Experiment Station, diamondback moth (DBM) became abundant after applications of methomyl against common cabbageworm in the cauliflower field but not in the untreated field.

This paper describes results of experiments conducted to analyze the process of DBM resurgence.

The role of predator and parasite was evaluated by artificially excluding them for estimation of DBM mortality. The results showed importance of natural enemies in reducing DBM population. And lycosid spiders were reduced through the application of methomyl, and were important biotic mortality agents of DBM based on immunological test. These results suggest that ground-crawling predators like lycosid spiders play an important role as a biotic mortality agents of immature stages of DBM.

Pardosa astrigera is the most common lycosid in the field. The LC_{50} to lycosids was around 10 ppm as against about 7,500 ppm for 4th instar DBM larvae using the dipping method and about 2,000 ppm for 3rd instar larvae by feeding methomyl-contaminated cabbage leaves.

Applications of sublethal concentrations of methomyl to 4th instar larvae and pupae of DBM resulted in increased fecundity of the adults which emerged. The adult females derived from the treated pupae laid more eggs with a higher rate of fertilization as compared with the untreated check.

It is suggested that the application of methomyl might cause a resurgence of the insect population through differential mortality between predators and pray and the stimulation of the reproductive potential.

RESURGENCE OF CITRUS RED MITE *Panonychus citri* McGregor INDUCED BY SYNTHETIC PYRETHROIDS. Kaichi Furuhashi(Shizuoka Citrus Experiment Stn.2-12-10 Komagoenishi Shimizu-shi,Shizuoka -ken,424,JAPAN)

In Japan,synthetic pyrethroids registered as insecticide for fruit trees in 1985,have been used insecticidal action on insect pests. However,synthetic pyrethroids offten cause a serious problem of unusual outbreaks of citrus red mites,so-called "Resurgence" by their application in orchards and tea fields.This disadbantage prevents the synthetic pyrethroids from extensive use.

The resurgence of citrus red mite was studied for elucidating mechanism of the resurgence development and preventive measures against the the resurgence of mites induced by synthtic pyrethroids.

The elucidation of the mechanism of resurgence development will help foward the establishiment of the resurgence preventive measures and faciliate the insecticidal application of synthetic pyrethroids.

FENAZAQUIN, A NEW ACARICIDE/INSECTICIDE. C. J. Hafton, J. M. Babcock, J. R. Schoonover, and J. E. Dripps. (DowElanco, P.O. Box 9002, Walnut Creek, CA. 94598, U.S.A.)

Fenazaquin, 4-[2-[4-(1,1-dimethylethyl)phenyl]ethoxy] quinazoline (XDE-436), represents a new class of acaricidal and insecticidal chemistry. It is presently being developed for mite control in stone and pome fruits, and row crops. Fenazaquin has been evaluated in several hundred field trials throughout the world. It controls two-spotted spider mite (*Tetranychus urticae*), citrus rust mite (*Phyllocoptruta oleivora*), European red mite (*Panonychus ulmi*), and citrus red mite (*Panonychus citri*) at rates of 75 to 150 g/ha on a variety of important crops. It is also active against several species of economically important Homoptera.

Fenazaquin is active on all mite developmental stages and has a novel and potent mode of action. In testing with resistant mite strains, cross-resistance to other widely-used acaricides was not observed. It provides effective residual control, however, residues are not so persistent as to accelerate selection for resistance. How fenazaquin fits mite IPM programs is being studied. It has demonstrated good selectivity to *Typhlodromus pyri* and *Euseius stipulatus* under field conditions, although it was not selectively less toxic to *Phytoseiulus* spp. in laboratory bioassays. It is safe to coccinellids, chrysopids, and nabids with LC_{50} values of >200 - 1000 ppm.

PROPERTIES AND TOXIC ACTION OF THE PERFLUORINATED SULFONAMIDE INSECTICIDE, SULFLURAMID. G. Gadelhak and R.M. Hollingworth, (Pesticide Research Center, Michigan State University, E. Lansing, MI 48824, USA).

Sulfluramid (N-ethyl perfluorooctanesulfonamide) is a novel slow-acting insecticide which is effective in bait formulations against a variety of insects. Cockroaches exposed to sulfluramid exhibit no symptoms of excitation but do develop an elevated respiratory level which suggest a possible action on mitochondrial functions. Sulfluramid itself is only a weak uncoupler of oxidative phosphorylation in vitro, but its N-deethylated metabolite is considerably more active. Possible further metabolism results in perfluorooctanesulfonic acid. The interactions of these compounds with mitochondria and the relationship between metabolism and toxicity will be discussed.

Diafenthiuron, a Novel Insecticide/Acaricide. F.J. Ruder, D. Käding, H. Kayser, W. Kobel, H.-P. Streibert (CIBA-GEIGY Ltd., Business Unit Insect Control, CH-4002 Basel, Switzerland)

Diafenthiuron (POLO/PEGASUS) is a new type of thiourea derivative with promising acaricidal and insecticidal activity. It gives good control of phytophagous mites as well as whiteflies, diamond back moths, some other lepidopteras, aphids and jassids in cotton, vegetables, hops, tea and ornamentals. Furthermore, the favorable acute mammalian toxicity, coupled with its good selectivity on beneficial insects and predatory mites, indicates that diafenthiuron will be an outstanding compound for future use. It is moderately hazardous to mammals, repeated exposure should be minimized. Its environmental properties are favorable. The active ingredient is toxic to aquatic organisms, but fast degradation in water and soil makes the product acceptable for its defined uses. Diafenthiuron is a pro-insecticide which is converted by sunlight and also biotically to the carbodiimide CGA 140408, the active compound. CGA 140408 is a potent mitochondrial inhibitor with a mode of action which is different from that of all current major pesticides on the market. It is slowly acting, leading to paralysis. Although the pest is not killed at once, its inability to move or to feed stops the damage very quickly. Diafenthiuron should be considered a new opportunity due to the novel mode of action and consequent low risk of cross resistence. Diafenthiuron is thus not a product for continuous spraying but rather a very special product with advantages for use in anti-resistance and IPM programmes.

HETEROCYCLIC INSECTICIDES ACTING AT THE GABA-GATED CHLORIDE CHANNEL. John E. Casida (Pesticide Chemistry and Toxicology Laboratory, Department of Entomological Sciences, University of California, Berkeley, CA 94720, U.S.A.)

Three billion (3×10^9) pounds of hexachlorocyclohexanes, polychlorobornanes and chlorinated cyclodienes (such as lindane, toxaphene, and endosulfan, respectively) were used to control pest insects before their mode of action was established as blocking the γ-aminobutyric acid (GABA) - gated chloride channel. With the restricted use or demise of these polychlorocycloalkanes (each ~50 to ~75% by weight of chlorine), the GABAergic system is for now an underutilized target of insecticide action. Newer compounds with outstanding potency at this receptor and as toxicants to houseflies are suitably-substituted 2,6,7-trioxabicyclo[2.2.2]octanes, particularly the bicycloorthobenzoates and 1,3-dithianes, including those with no halogenated substituents. Picrotoxinin analogs and alkynylphenylsilatranes also act at this target but are of lower insecticidal activity. [^{3}H]n-Propyl-ethynylbicycloorthobenzoate ([^{3}H]EBOB) is for now the best radioligand for this insecticidally-relevant binding site in insects. Macrocyclic lactones such as the avermectins and moxidectin act at a different binding site to disrupt chloride flux and they have a different spectrum of insecticical activity and no cross resistance with cyclodienes in houseflies. The search for new insecticides has provided the incentive and probes for a better understanding of the insect GABAergic system.

MECHANISM OF ACTION AND PESTICIDAL PROPERTIES OF THE PYRROLE AC 303,630. M.F. Treacy, T.P. Miller, B.C. Black and I.E. Gard (Insecticide Discovery, American Cyanamid Co., P.O. Box 400, Princeton, NJ 08543 USA)

Following isolation and characterization of dioxapyrrolomycin (derived from fermentation culture of Streptomyces fumanus) by the Lederle Laboratories of American Cyanamid Co., bioassays demonstrated that this compound possessed moderate activity against selected species of mites and insects. Based on these findings, synthesis work was started at Cyanamid and subsequently led to discovery of a wide range of insecticidal and acaricidal aryl-substituted pyrroles. The pyrrole AC 303,630 was first synthesized and characterized in 1988.

Laboratory and field assays have shown foliar applications of AC 303,630 to be highly active against at least 50 species of mites and insects which attack crops such as cotton, citrus, tree fruit and vegetables. Mechanism-of-action studies have indicated that AC 303,630 targets mitochondria, and exerts its lethal effect in insects by uncoupling oxidative phosphorylation. Preliminary assays suggest that AC 303,630 may be a pro-drug, and may require activation within the insect via oxidative metabolism. AC 303,630 has been shown to be highly active against insect and mite species known to possess resistance to organophosphate, carbamate and pyrethroid pesticides. Other biological characteristics of AC 303,630 include: (1) moderate contact and excellent stomach toxicity against insects; (2) good acaricidal activity via translaminar movement in plant foliage; but (3) very little plant-systemic insecticidal activity.

NITROMETHYLENE INSECTICIDES: ACTIONS ON INSECT NICOTINIC ACETYLCHOLINE RECEPTORS

D.B. Sattelle (AFRC Laboratory of Molecular Signalling, Department of Zoology, Cambridge CB2 3EJ, UK).

Nitromethylenes and their analogues are a new class of insecticidally active molecules of commercial importance. A novel nitroguanidine analogue, 1-(6-chloro-3-pyridylmethyl)-N-nitroimidazolidin-2-ylideneamine (imidacloprid) and a nitromethylene, 1-(3-pyridylmethyl)-2-nitromethylene-imidazolidine (PMNI) have been studied on the cockroach fast coxal depressor motor neurone D_f. Also, their effectiveness in displacing [^{125}I]alpha-bungarotoxin binding to a cockroach nerve cord preparation has been investigated. When tested on the cell body of this identified neurone both imidacloprid and PMNI induce slow depolarizations, which are sensitive to nicotinic receptor antagonists, such as dihydo-beta-erythroidine (1.0×10^{-5}M) and mecamylamine (1.0×10^{-4}M). Lower concentrations of imidacloprid (1.0×10^{-8}M-1.0×10^{-6}M) and PMNI (1.0×10^{-8}M) show no antagonist action on nicotine-induced depolarization. However, at concentrations in the range 1.0×10^{-7}-5.0×10^{-7}M, PMNI partially and reversibly blocks nicotine-induced depolarization. Both compounds are more effective displacers of specific [^{125}I]alpha-bungarotoxin binding than nicotine, with imidacloprid ($IC_{50}=2.0 \times 10^{-7}$M) about tenfold more potent than PMNI ($IC_{50}=1.3 \times 10^{-6}$M). Possible mechanisms of acetylcholine receptor-nitromethylene actions are assessed.

GABA RECEPTOR AS A TARGET FOR INSECTICIDE ACTION. Fumio Matsumura (University of California, Davis, California, 95616 USA)

The importance of GABA receptors as a target for insecticides was initially noticed when insect strains resistant to cyclodiene insecticides showed specific cross-resistance to picrotoxinin, an agent known to attack mammalian CNS-$GABA_A$ receptors. Also development of bicyclophosphate analogs as GABA receptor targeted insecticidal agents facilitated the advancement of this concept. Insect GABA receptors, while they are fundamentally similar to mammalian counterpart, appear to have some specific characteristics: e.g. the lack of benzodiazepine and bicuculline sensitivities and their peripheral localization, in addition to CNS, etc. In this presentation the details of both chemical (e.g. structure-activity relationship studies) and molecular biological study results will be provided to describe the specific characteristics of insect GABA receptors.

ACTION OF ESTABLISHED AND EXPERIMENTAL INSECTICIDES ON VOLTAGE-SENSITIVE SODIUM CHANNELS. David M. Soderlund (Dept. of Entomology, New York State Agricultural Experiment Station, Cornell University, Geneva, New York 14456, U. S. A.)

Voltage-sensitive sodium channels have long been recognized as the principal target site for both DDT analogs and pyrethroids. Biochemical investigations show that these classes of insecticides have a common mode and site of action on sodium channels. Two classes of experimental insecticides, the *N*-alkylamides and dihydropyrazoles, also appear to alter sodium channel function. These classes appear to act at separate binding sites, each of which is distinct from the DDT/pyrethroid site. Thus, the voltage-sensitive sodium channel contains at least three separate insecticide target sites. The multiplicity of insecticide-binding domains on the sodium channel has important implications for the continued exploitation of this target in the search for new agrochemicals and for the understanding of insecticide resistance mechanisms that involve the expression of sodium channels with altered insecticide recognition properties.

OCTOPAMINE RECEPTORS AS BIOCHEMICAL SITES FOR THE DEVELOPMENT OF INSECT-SPECIFIC TOXICANTS. Robert M. Hollingworth, Nailah Orr and Gregory L. Orr (Pesticide Research Center and Neuroscience Program, Michigan State University, E. Lansing, MI 48824 USA)

Octopamine is now recognized as a major neurotransmitter and neuromodulator in insects and acarines with little known functional significance in vertebrates. Its biochemistry thus may provide an opportunity for the development of insect-specific toxicants. Compounds that stimulate octopaminergic systems in insects cause physiological, behavioral and lethal effects that have often been highly compatible with IPM programs. However, with the demise of the major octopaminergic pesticide, chlordimeform, new opportunities and needs exist for alternative compounds. This talk will review the current knowledge of octopaminergic biochemistry with special attention to receptor agonists and antagonists. Significant variations exist between species and tissues in the properties of OA receptors and these may be related to differences in field effectiveness of different agonist classes. Convenient systems for the assay of octopaminergic effects are needed in research and screening. Recent studies with an insect ovarian cell line from *Spodoptera frugiperda* (Sf9) indicate that the cells provide a useful model system for the further study of octopamine receptors and compounds that affect them.

INTERACTIONS OF THE JUVENILE HORMONE RECEPTOR WITH DIFFERENT INSECT GROWTH REGULATORS. Lynn M. Riddiford and S. R. Palli, Department of Zoology, University of Washington, Scattle, WA 98195, USA.

Juvenile hormone (JH) has pleiotropic actions in insect cells, one of which appears to be mediated by a nuclear receptor. Initial biochemical analysis of *Manduca sexta* epidermal nuclei using ^{3}H-JH I or ^{125}I-iodovinylmethoprenol showed the presence of a high affinity binder (nanomolar K_d) for each but no competition between the natural hormones and the dodecadienoates (Osir & Riddiford, *J. Biol. Chem.* **263**, 13812-18, 1988). ^{3}H-photoaffinity analogs of both the natural JHs (EBDA and EHDA) and methoprene (MDK) specifically labeled 29kD nuclear proteins, one of pI 5.8 for JH I and II and one of pI 6.0 for methoprene, but MDK also nonspecifically bound the pI 5.8 protein. Isolation and partial sequencing of the JH-binding 29kD protein (K. Touhara, R. Atkinson, and G.P. Prestwich, personal communication) allowed us to isolate its cDNA. Bacterially-produced protein from this cDNA is now being tested for its ability to bind the natural JH's and/or their analogs. In *Drosophila melanogaster* JH I, III, and JH III bisepoxide, methoprene, and pyriproxyfen all inhibit metamorphosis of the abdominal histoblasts with pyriproxyfen being most active. Studies with the *methoprene-tolerant* (*Met*) mutant that has increased resistance to methoprene by virtue of a reduced cytosolic binding of methoprene (Shemshedini and Wilson, *Proc. Nat. Acad. Sci. USA* 87, 2072-2076, 1990) show that it is cross-resistant to pyriproxyfen, indicating that this altered protein must be critical for JH action, whether for transport to the nucleus or for actual nuclear action.

MODE OF ACTION OF JUVENILE HORMONE AND MIMICS IN FAT BODY.
G.R. Wyatt (Department of Biology, Queen's University, Kingston, Ontario K7L 3N6, Canada).

For the further development of JH mimics for use in insect pest control, it is important to understand how their biological activities are related to chemical structure. This is at present poorly understood. As one approach, we are studying the juvenoid regulation of synthesis of specific proteins in fat body, through modulation of expression of their genes. In the locust, several proteins have been characterized whose synthesis is induced or repressed by JH and JH mimics. Because the activities of methoprene and pyriproxyfen are correlated in various assays in both the locust (L. migratoria) and the armyworm (Pseudaletia unipuncta), we believe that, despite very different chemical structures, these two JH mimics and JH itself use the same primary mechanism of action. Induction of locust vitellogenin gene transcription involves a lag of at least 12 hours, during which protein synthesis is required. Specific DNA-binding proteins that are modulated during JH action have been identified. In fat body nuclei and extracts, ^{3}H-JHIII, -methoprene and -pyriproxyfen bind to several components, one of which may be the JH receptor. The structure/activity relationship must eventually be resolved by analysis and modelling of the juvenoid/receptor complex. (Supported by NSERC of Canada, Insect Biotech Canada and the Sumitomo Chemical Company).

EXPRESSION OF JUVENILE HORMONE ESTERASE IN VITRO AND IN VIVO BY RECOMBINANT BACULOVIRUSES. S. Maeda, R. Ichinose, V. Ward, S. G. Kamita, B. Bonning, T. N. Hanzlik, and B. D. Hammock. (Department of Entomology, University of California, Davis, CA 95616, U.S.A.)

A recombinant Autographa californica nuclear polyhedrosis virus (AcNPV) containing cDNA coding for juvenile hormone esterase (JHE) of Heliothis virescens has been shown to cause physiological and insecticidal effects in Trichoplusia ni. A recombinant Bombyx mori nuclear polyhedrosis virus (BmNPV) carrying JHE cDNA was made based on previous constructs. Expression and posttranslational modifications of JHE expressed by recombinant baculoviruses in established cell lines and larvae were studied. Expression levels were higher in larval hosts than in established cell lines using both the BmNPV and AcNPV expression systems. Glycosylation and cleavage of secretion signals of expressed JHE were slightly different in vitro and in vivo. Pharmacokinetics studies of larvae (Manduca sexta) injected with JHE purified from recombinant baculovirus-infected cells, showed a rapid clearance of the injected JHE from hemolymph, indicating specific JHE degradation mechanisms in insects.

ENVIRONMENTAL STABILITY OF PYRIPROXYFEN AND ITS APPLICATION FOR INSECT PEST CONTROL. P. A. Langley (ODA/University of Bristol, Langford House, Langford, Bristol BS18 7DU, England), B. Mauchamp (France), C. Royer (France) and H. Oouchi (Japan)

Pyriproxyfen induces "sterility" in tsetse flies by causing them to produce offspring which fail to metamorphose. Suppression of reproduction was achieved under field conditions in Zimbabwe, when flies passed through traps and brushed against fabric surfaces treated with an oil formulation of pyriproxyfen. A similar effect was achieved with treated targets. The formulation is highly stable in the field and even after 12 months, momentary contact with a treated surface reduced offspring viability to between 28% and 43% of control values in *Glossina morsitans morsitans*. The technique has great potential for use with other insect pests.

PYRIPROXYFEN, A NOVEL SELECTIVE INSECTICIDE
M.Hatakoshi, M. Hirano, J. Miyamoto (Takarazuka Research Center, Sumitomo Chemical Co. Ltd., Takarazuka, Hyogo 665, Japan)

Pyriproxyfen [4-phenoxyphenyl (*RS*)-2-(2-pyridyloxy) propyl ether], a juvenile hormone analog, has a hign potency to control some insects that are generally less sensitive to conventional insecticides. We examined the effect of pyriproxyfen on field population of such insects.

The efficacy appeared gradually, but continued for a longer period as compared to those of conventional insecticides. By the laboratory tests, metamorphosis and reproduction were confirmed to be affected.

Inhibitory effects on metamorphosis and reproduction of *Spodoptera litura* by pyriproxyfen were due to residues of the compound at high level in the hemolymph and an acceleration of prothoracicotropic hormone release, and due to lack of an oviposition stimulating factor, respectively.

NOVEL INSECT GROWTH REGULATORS: BIOCHEMICAL ASPECTS AND AGRICULTURAL IMPORTANCE. Isaac Ishaaya and A. Rami Horowitz (Dept of Entomology, ARO, The Volcani Center, Bet Dagan Israel)

Benzoylphenyl ureas such as chlorfluazuron, teflubenzuron and hexaflumuron have been introduced in Israel for controlling Spodoptera littoralis in cotton and ornamentals, teflubenzuron for controlling the grape vine moths Lobesia botrana and Cryptoblabes gnidiella. Buprofezin acting specifically on some homopteran pests is very effective for controlling the sweetpotato whitefly Bemisia tabaci.

In addition to the above chitin synthesis inhibitors. The juvenoid compound pyriproxyfen was found to be a powerful insecticide for controlling whiteflies and scale insects. The compound exhibits a strong ovicidal and transovarial activity, suppressing embryogenesis and egg hatch. Exposure of B. tabaci females for 48 h to cotton leaves treated with 5 ppm pyriproxyfen resulted in oviposition of non viable eggs. This effect was persistent for additional 6 days, after the transfer of females to untreated leaves. Treatment of 2nd-instars with 0.05-5.0 ppm pyriproxyfen resulted in total suppression of adult emergence. These larvae excreted honeydew at similar level as the control until the start of pupation, after which a strong reduction of honeydew secretion was observed. The compound exhibits translaminer activity affecting hidden larvae present at the underside surface of the leaves.

The diversity of IGRs; acting selectively on various groups of insects, are considered important components in IPM programs.

ECDYSONE AGONISTS, A NEW GENERATION, INSECT GROWTH REGULATOR. Arthur Retnakaran (Forest Pest Management Institute, Forestry Canada, P.O.Box 490, Sault Ste. Marie, Ontario, Canada, P6A5M7) Substituted dibenzoylhydrazines, RH-5849 and RH-5992, were found to be potent agonists of 20-OH ecdysone when tested on several lepidopteran larvae, the latter compound being more active than the former. Upon ingestion the larvae showed characteristic molting effects. The phenotypic and structural changes were studied under the light and electron microscopes. Time-course investigation revealed, sequential changes similar to the normal molting cycle excepting for the conspicuous absence of the endocuticular lamellae. Molecular effects were examined using *in vitro* cultures of the integument and selective probes for some epidermal genes. Field efficacy studies indicated that RH-5992 will be an excellent control agent for the spruce budworm, *Choristoneura fumiferana*, the dosage being as low as 35g/ha. This compound appears to specifically act on the ecdysone receptor of insects (primarily on Lepidoptera) since it does not have any molting hormone activity on crustaceans and arachnids.

BUPROFEZIN, MODE OF ACTION AND AGRICULTURAL IMPORTANCE. M. Uchida and T. Konno (Nihon Nohyaku Co., Ltd., Research Division, 4 - 31 Honda - cho, Kawachinagano, Osaka 586, JAPAN)

Buprofezin is one of insect growth regulators (IGRs) and shows high activity on hemipterous insect pests such as plant - and leaf - hoppers, whiteflies and scales. The chemical also provides excellent persistency of the effect in the field without any practical harm to beneficials and non - target organisms. Since its introduction buprofezin has been used as a prominent IGR for effective Integrated Pest Managements of rice, vegetables, cotton, citrus and so on, especially where they have resurgence and existing resistance problems.

Buprofezin exhibits larvicidal activity at the end of an instar by preventing the molting process. It also inhibits oviposition and / or promotes oviposition of unhatchable eggs, depending on the age of famale adults treated. The recommended mode of action on larvae is the disruption of ecdysteroid - regulation followed by the inhibition of chitin biosynthesis.

Since benzoylphenyl ureas (BPUs) also inhibit chitin biosynthesis, buprofezin is sometimes classified into BPUs, though its insecticidal spectra is quite different from those of BPUs. We will discuss our recent findings to show some possible differences in the mode of action of these compounds.

TOXICITY AND DISTRIBUTION OF BENZOYLPHENYL UREAS IN *SPODOPTERA EXEMPTA* (WLK.). D. Degheele & C. Bai (Laboratory of Agrozoology, Faculty of Agricultural Sciences, University of Gent, Coupure Links 653, B-9000 Gent (Belgium).

The biological activity of four benzoylphenyl ureas (BPUs) has been assessed against the African armyworm *Spodoptera exempta* (Wlk.) (Lepidoptera: Noctuidae) under laboratory conditions. All of them have a high level of larvicidal activity to the third instar: the LC_{50} - values are 0.006, 0.007, 0.035 and 0.062 mg/l 72 h after exposure for teflubenzuron, hexaflumuron, flufenoxuron and diflubenzuron respectively. The ovicidal activity is much greater on young eggs: the LC_{50} - values are 0.186, 0.947, 0.490 and 5.843 mg/l to 0 - 24 h eggs and 0.420, 5.966, 1.085 and 18.493 mg/l to 24 - 48 h old eggs for hexaflumuron, teflubenzuron, flufenoxuron and diflubenzuron, respectively. The LC_{95} for hexaflumuron was less than 4 mg/l.

After 24 h, two and three times more radiolabelled teflubenzuron was detected in the cuticle of sixth-instar larvae in comparsion with ^{14}C -hexaflumuron and ^{14}C -diflubenzuron, respectively; the excrements contained 80, 74 and 57% diflubenzuron, hexaflumuron and teflubenzuron, respectively. It can be concluded that the higher toxicity of teflubenzuron (and hexaflumuron) is probably due to its higher retention in the larval body and in particular in the cuticle.

EFFECTS OF BENZOYLPHENYL UREAS ON HORMONE BALANCE OF THE ORIENTAL ARMYWORM (MYTHIMNA SEPARATA(WK.)) AND ITS APPLICATION IN PEST CONTROL. Guoji Gong, Ziping You (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China)

Studies in laboratory and field indicated that the contact toxicities of BPU's to the 3rd, 4th and 6th instar larvae of the oriental armyworm were resemble to that of deltamethrin and higher than that of organophosphorus. The mode of action of BPU's was also studied in symptomology, histology and biochemistry. It was found that the symptom was similar to JHA, and that the toxicities had no direct relation to the inhibition of chitin, but was relative to the development stage when larvae received chemicals. After the larvae were treated with BPU's, chitin and protein content in cuticle was decreased synchronously, and the NSCs in brain, CA and PG were all in abnormal condition. Futher studies showed that 48-60 hr after molting was a critical period for JH level and at this time JH titre decreased to the lowest threshold. In BPU's treated larvae, the JH titre was about 70-fold higher than that of control, the Ec peak at 5th days after molting was inhibited about 70% by BPU's in vivo and not in vitro. The activation of PG by PTTH also inhibited, but could be resume by excessive PTTH. And the cAMP which usually marks the hormone peak was inhibited by approximately 47.5 and 25.2% in brain and PG, respectively. All these results confirmed that BPU's is an effective regulator and its effect to hormone balance is an important factor in its mode of action.

INSECT CYTOCHROME P450. Jeffrey G. Scott (Department of Entomology, Comstock Hall, Cornell University, Ithaca, NY 14583 U.S.A.)

The microsomal cytochrome P450 monooxygenases are an extremely important metabolic system responsible for the metabolism of endogenous compounds such as hormones and xenobiotics such as pesticides. The large number of substrates that are attacked by the monooxygenases is due to the presence of several different P450s in a given organism. Given the complexity of the monooxygenases it is necessary to isolate and characterize the individual P450s. We have recently purified a cytochrome P450, termed P450lpr from the LPR strain of house fly. A polyclonal antiserum was raised, shown to be specific for P450lpr and has been used to characterize this P450.

Anti-P450lpr inhibited 97% of the deltamethrin metabolism, 98% of the methoxyresorufin-O-demethylase activity and all the benzo(a)pyrene hydroxylase activity in LPR microsomes. The antiserum partially inhibited ethoxyresorufin-O-dealkylase and ethoxycoumarin-O-dealkylase activity). Based on these data, P450lpr is the major P450 responsible for the metabolism of deltamethrin, benzo(a)pyrene and methoxyresorufin, but not ethoxycoumarin or ethoxyresorufin in LPR microsomes. The relatedness of P450lpr to the more widely studied mammalian P450s will be discussed.

INDUCTION AND PURIFICATION OF MICROSOMAL CYTOCHROME P-450, NADPH-CYTOCHROME P-450 REDUCTASE AND ITS ACTIVITIES OF RECONSTITUTED ENZYME SYSTEM. Junyong Huang and Xin-fu Leng (Department of Pesticide Chemistry and Toxicology, Institute of Zoology, Academia Sinica, Beijing, China, 100080)

In the current study, components of cytochrome P-450 enzyme system derived from rat hepatic-microsome by sodium phenobarbital induced were characterized. A major form of cytochrome P-450 isozymes was purified by using a major procedures involving PEG fractionation and chromatography on column of DEAE-Sephacel (3.6 × 22cm) in the presence of 2% Lubrol PX and potassium phosphate buffer as elution solvent. Only a 55 KD protein band appeared on the SDS-PAGE (10% separation gel) and exhibited that the maximum of the absorption peak of the CO-difference sepctra was at 450 um. NADPH-cytochrome P-450 redulase was partialty purified via ammonium sulfate fractionation and chromatography on column of DEAE-Sephacel (2.8 × 22cm) containing 1.5% Lubrol PX in Tris-HCl etution buffer. There are two protein bands with molecular weight 72 and 77 KD respectively appeared on the SDS-PAGE (7% separation gel). The activities of reconstituted enzymes system including cytochrome P-450 reductase and Phospholipid which are active in hydroxylation toward cyclohexane and epoxidation toward aldrin have only poor ability for hydroxylation toward deltamethrin. And the activity of hydroxylation toward cyclohexane can not be detected when the purified cytochrome P-450 was lacked in this reconstituted enzymes system.

INSECT GLUTATHIONE S-TRANSFERASES. W.C. Dauterman, Department of Toxicology, North Carolina State University, Raleigh, North Carolina, 27695, U.S.A.

Glutathione S-transferase catalyze the detoxication of a wide variety of electrophilic compounds by conjugating them with reduced glutathione. The enzymes are found throughout the animal and plant kingdom.

A brief overview of the literature on glutathione S-transferases will be presented, followed by a discussion of the purification and separation of insect glutathione S-transferases. Special emphasis will be placed on the role that insect glutathione S-transferases play in insecticide resistance.

CONJUGATION REACTIONS. H. Wyman Dorough (Department of Biological Sciences, Mississippi State University, Miss. State, MS 39759, U.S.A.)

In animals, bioalteration of most xenobiotics involves a multitude of chemical reactions occurring simultaneously and sequentially in a superbly synchronous fashion that leads to the successful elimination of the material from the body. Modifying these processes may make certain safe chemicals unsafe, or render normally tolerant individuals susceptible to the harmful manifestations of the agent at hand. Bioalterations occurring initially are referred to as Primary or Phase I Metabolism and include oxidative and hydrolytic reactions that, at least for insecticides, are well recognized by all in the entomological sciences. Not so well recognized by these, or other scientists, are conjugation reactions, called Secondary or Phase II Metabolism because they are usually dependent upon a Primary reaction to convert the xenobiotic into a chemical form suitable for conjugation, its covalent bonding with an endogenous substance. The resulting product, or conjugate, is almost always more polar and less biologically active than its xenobiotic precursor. This paper will address conjugates (glucosides, glucuronides, sulfates, glutathiones, etc.) as they relate to the metabolism, fate and environmental significance of organic insecticides.

PHOTOCHEMISTRY OF INSECTICIDES : CHEMICAL AND ENVIRONMENTAL PERSPECTIVES. Luis O. Ruzo, Kathryn Shepler and Jeffry Lawrence. PTRL-West, Inc., 4123-B Lakeside Dr., Richmond, California 94806.

Photodecomposition processes of insecticides continue to be of interest for:a) design of compounds with adequate field lifetimes, b) assesment of environmental fate and its impact on regulatory decisions and c) understanding of photochemical processes and related environmental factors.

Structure/reactivity relationships of insecticidal compounds relative to photolysis will be reviewed on the basis of recent literature reports. Chemicals exhibiting unusual reactivity will be emphasized. Approaches which allow for comparison of laboratory and field behavior will be discussed taking into account reaction media, light sources and the effect of oxidizing species. Thus, reactions in solution, soil surfaces and in the gas phase will be compared.

DESIGN OF PROINSECTICIDES. Noriharu Umetsu (Agrochemicals division, Otsuka Chemical Co., Ltd., Ote-dori, Chuo-ku, Osaka 540, Japan)

Generally the term "proinsecticides" defines those insecticide chemicals which are intrinsically inactive compounds, but are altered either chemically or biologically to intrinsically active toxic substances.

In this presentation on the design of proinsecticides, examples are given with six different classes of insecticides, i.e., the procarbamates, proinsecticidal phosphoramidothioates, pronereistoxins, proformamidines, 29-fluorophytosterols and fluorinated toxicants. All of the proinsecticides were intentionally designed and prepared on the basis of their anticipated activation in biological systems. Derivatization of active insecticides provides an easy means of generating a variety of new compounds with different kinds of insecticidal activities. In most cases, notable improvement in mammalian toxicity was achieved along with the retention of insecticidal activity via 1) "delayed factor" provided by the attached functional group, 2) species difference in balance of activation and detoxication reactions, and 3) difference in the physical properties of the derivatives. Other favorable properties also obtained by the derivatization were enhancement of activity and persistence, reduction of phytotoxicity, acquirement of phloem-mobility, and delayed toxicity. A number of proinsecticides have attained commercial importance as useful agrochemicals or are currently being developed for commercial use.

THE EFFECTS OF IMPURITIES ON THE MAMMALIAN TOXICITY OF INSECTICIDES. Janice E. Chambers and Gary D. Dorough (College of Veterinary Medicine, Mississippi State University, Mississippi State, Mississippi 39762, U.S.A.)

The mammalian toxicity of several insecticides can potentially be enhanced by the presence of impurities which have greater potency at the same active site or an alternative mechanism of action leading to toxicity in another target system. Some of the rearrangement products caused by light or heat in some sulfur-containing organophosphorus insecticides, such as malathion, are far more potent antichotinesterases than mataoxon. Some of these rearrangement products also are immunotoxic and may be capable of compromising immune system function, while others cause a delayed pulmonary toxicity. Another impurity exerting an alternative action is the o,p'-isomer of DDT which comprises about 20% of the technical DDT mixture. While not very potent as an insecticide compared to p,p'-DDT, o,p'-DDT is estrogenic because of its abitity to bind to estradiol receptors in both mammalian and avian test systems. This activity may deleteriously impact normal reproductive cycles and success in exposed animals. The toxicological significance of these impurities will depend upon the amount formed as welt as their stability in the organism. Supported by National Institutes of Health Grant K04 ES00190.

EFFECTS ON NON-TARGET ARTHROPODS. Heimbach. Udo (Federal Biological Research Centre for Agriculture and Forestry, Institute for Plant Protection in Field Crops and Grassland, 3300 Braunschweig, Germany)

When using pesticides to control pest insects nontarget arthropods are hit also. Many species of the non-target organisms are beneficials e. g predators and parasitoids and should be protected to keep their beneficial capacity working in the fields. That is why since many years much effort is spent on selecting pesticides which are harmless to beneficial species especially in greenhouse crops.

Some years ago a three step testing procedure has been developed: a laboratory tests of singte species as a "worst case" test followed by semi-field and field tests. The laboratory test is used to find out harmless pesticides that have not to be tested further on. The other two testing schemes are used to simulate the effects that will occur in the field. But it has to be considered that in the field the exposition and sensitivity of the species as well as the agricultural practise can influence the results. Thus soil texture, temperature and tank mixture of pesticides influenced the rate of mortality of carabid beetles and the sensitivity of two carabid species tested was different.

BREEDING FOR PESTICIDE RESISTANCE IN APHYTIS BY STANDARD AND MALE SELECTION METHODS. A. Havron & D Rosen, Faculty of Agriculture, the Hebrew University, Rehovot 76100, Israel.
Field-collected populations of Aphytis holoxanthus DeBach and of A. lingnanensis Compere (Hymenoptera: Aphelinidae) were tested for malathion and for azinphosmethyl resistance. Significant levels of azinphosmethyl resistance were discovered in 2 populations of A. holoxanthus and one of A. lingnanensis, and were further increased by selection to X24-48 and X40 that of susceptible laboratory populations of the respective species. The male selection method was applied for 7 generations to the initially selected A. lingnanensis stock, and azinphosmethyl resistance further increased to X80 that of the susceptible stock.
This improved strain has been released in Israel against Aonidiella aurantii (Maskell), and in the Philippines against A. aurantii and Unaspis citri (Comstock) in citrus orchards.
No significant differences in malathion tolerance were observed between field populations of A. holoxanthus, and neither 30 cycles of mass selection nor 25 cycles of male selection achieved any significant levels of resistance

MICROSOMAL NADPH-OXIDATION (IN THE ABSENCE AND PRESENCE OF CYTOCHROME c) AND NADPH-CYTOCHROME c (P-450) REDUCTASE ACTIVITY IN ADULTS OF THE RESISTANT AND SUSCEPTIBLE STRAINS OF COLORADO POTATO BEETLE, Leptinotarsa decemlineata Say (COLEOPTERA: CHRYSOMELIDAE). Ahmad Mahdavi (College of Agriculture, University of Mazandaran, Sari, Iran).

The presence and importance of cytochrome P-450-dependent mono-oxygenases systems in the metabolism of xenobiotics, including insecticides, is well-established in insects. Mono-oxygenase activity depends on an electron transport system, NADPH, and molecular oxygen. Microsomal NADPH-oxidation was measured in susceptible and insecticide-resistant strains of Colorado potato beetle and demonstrated a correlation between these activities *in vitro* and insecticide resistance shown *in vivo*. Significantly higher microsomal NADPH-cytochrome c (P-450) reductase activity in the resistant Sherbrooke strain (5.7 fold) compared to the susceptible strains correlates with the resistance shown by this strain in both larvae and adults. The importance of mono-oxygenases in the resistance of insects against insecticides will be discussed.

PESTICIDAL AND BIOCHEMICAL ASSAYS OF INSECTICIDE RESISTANCE IN THE TUFTED APPLE BUD MOTH AND CODLING MOTH. Yehia A.I. Abdel-Aal (Plant Protection Department, College of Agriculture, Assiut University, Assiut, Egypt), Michael Bush, George C. Rock (Department of Entomology, North Carolina State University, Raleigh, NC 27695-7613 USA).

Pesticidal bioassay indicated that populations of the tufted apple bud moth, Platynota idaeusalis, and the codling moth, Cydia pomonella, from some apple orchards in North Carolina were resistant to azinphosmethyl and parathion, respectively. Biochemical assay showed that resistance in the tufted apple bud moth mainly appeared to be esterase-mediated, with an elevated esterase activity towards non-insecticidal esters in resistant phenotypes. Esterase banding-pattterns following electrofocusing of population samples, with different degrees of resistance to azinphosmethyl, indicated that resistance is linked to the presence and intensity of a detectable esterase electromorph. On the other hand, activity towards non-insecticidal substrates in the codling moth appeared to negatively correlate with resistance to parathion. This relationship may be due to the presence in resistant phenotypes of a mutant aliesterase, capable of hydrolyzing parathion but with reduced specificity to non-insecticidal esters.

Occurrence and Management of Insecticide Resistance in Diamondback Moth Populations in the U.S.A.

J.V. Edelson and J. Magaro

Oklahoma State University and Texas A&M University

In laboratory bioassays with selected insecticides labeled for application to cabbage, responses of field populations of diamondback moth larvae (Plutella xylostella) were compared with the response of a susceptible laboratory population. Insecticides tested included permethrin, methomyl, methamidophos, and Bacillus thuringiensis. At the LC90, resistance ratios were 13 for permethrin and 145 for methamidophos. This is the first documented occurrence of resistance to synthetic insecticides in North American diamondback moth populaitons. Results from bioassays with the susceptible colony were used to develop a field technique for monitoring diamondback moth larvae insecticide resistance in the field. The technique appears to be useful in making decisions about insecticide application in production fields.

MECHANISM OF CHLORFLUAZURON RESISTANCE IN THE DIAMONDBACK MOTH, PLUTELLA XYLOSTELLA (L.). Adel Ramzy Fahmy, Tadashi Miyata (Lab. Appl. Entomol. & Nematol., Fac. Agric., Nagoya Univ., Nagoya 464-01, Japan)

Two Thailand field strains of the diamondback moth, Plutella xylostella (Tup Luang and Bang Khae strains) which were reared in the laboratory for two years without exposure to any insecticidal pressure were selected for chlorfluazuron resistance in the laboratory. Resistant and non-selected (susceptible) strains were then used to investigate the cross resistance developed to other insecticides.There was strong evidence of the development of cross resistance to teflubenzuron and S-71624 (chitin synthesis inhibitors) and a little cross resistance to pyriproxyfen (JHA). There was no cross resistance to all the conventional insecticides tested. Joint action studies of chlorfluazuron mixtures with other insecticides revealed a clear potentiation with teflubenzuron and S-71624 especially in the resistant strains while there was no remarkable potentiation in the susceptible strains. Again there was no potentiation in both susceptible and resistant strains using conventional insecticides. Chlorfluazuron was synergized significantly with TPP, PB and teflubenzuron (LC1 was the maximum concentration used) especially in the resistant strains. Inheritance studies revealed that chlorfluazuron resistance is likely to be controlled by a single incompletely recessive gene with no sex linkage or maternal effect.

STUIES ON MONITORING AND MANAGEMENT OF THE RESISTANCE OF THE COTTON APHIDS TO INSECTICIDES IN THE WESTERN COTTON GROWING DISTRICT OF LIAONING PROVINCE. Deming Liu, Xiufen Yang, Benzhen Li & Fanxin Kong (Institute of Water and Soil Conservation, Liaoning 122000, China)

Studies on mornitoring and management of the resistance to determine the toxicity of six kinds of commonly used insecticide with the aim at comparing susceptibility between the aphids and obtaining the resistance index.

The resistance of cotton aphids to organophosphorus compounds has been increesing slowly, being up 500-700 times since 1960s, whereas the resistance to pyrethroids has been strikingly high (6.77-9937.47 R. S.) with 1.5-2 old increase each year. Resistance experiments have been done for three years. Experiment results and economic benefit have been described in the paper.

AN INVESTIGATION ON THE EFFECTIVENESS OF FENITROTHION ON DIFFERENT POPULATION OF CEREAL SUNN PEST *EURYGASTER INTEGRICEPS* PUT. (HEM.: SCUTELLEVIDAE) IN IRAN. Morteza Esmaeili, Mehran Juvadzadeh, M. J. hejazi and Kh. Talebi (Plant Protection Dpt. College of Agriculture of Tehran University, Karaj 31584 Iran)

Three populations of cereal sunn pest *Eurygaster integriceps* Put. With different history of Fenitrothion application against them have been tested for development of resistance against this insecticide. It is found that at least one population with 15 years of Fenitrothion applications against it has shawn considerable resistance.

RESISTANCE AND SELECTIVITY OF TOXITY 6 SPECIES OF APHIDS TO DELTAMETHRIN, FENVALERATE AND OMETHOATE. Kai-yun Wang, Li-yi Mu, Shi-an Zhang (Department of Plant Protection, Shandong Agricultural Univercity, Taian 271018, China)

6 species of agriculturally important aphids were collected from field, and treated with deltamethrin, fenvalerate and omethoate topically in 1985 and 1990. The results showed that *Aphis gossyppi* (Glover) from Dezhou develop resistance most quickly, with 6113.0-fold resistance to deltamethrin and 12576.8-fold resistance to fenvalerate. *Brevicoryne brassicae* (L.) from Taian is the second to fenvalerate. After are *Aphis pomi* (De Geer) from Laizhou, *Muzus persicae* (Sulzer) from Changle and Qingzhou tobacoo field, *M. persicae* from Feicheng peach orchard, *Aphis medicaginis* (Koch) from Laixi and *B. brasicae from* Taian to deltamethrin. *A. pomi* from Taian to fenvelerate. *A. pomi* from Laizhou and Taian to omethate had all developed relativety significant resistance. The relative susceptible strains of 6 speciesof aphids were tested with deltamethrin and omethate, the results demonstrated that there is evident selectivity in toxity among different species of aphids.

RESISTANCE OF *MYZUS PERSICAE* SULZ. TO ORGANOPHOSPHOROUS INSECTICIDES IN IRAN. S. H. Hodjat, P. Ahmadian & M. Moradeshagi (Shahid Chamran University, College of Agriculture, Dept. Plant Protection, Ahwaz-Iran)

Twenty aphids reared on pepper and egg plant, in the greenhouse in Tehran, walked in ten cm. diameter filter paper, treated with various concentrations of insecticides. One ml. of aceton was used on each filter paper, either with insecticides for treatments, or without it as control. Diazinon treatment of one ppm concentration produced 10-25% mortality after four hours. In the similar experiments 1000 ppm Malathion caused 10-20% mortality on other clones. Aphids used in these experiments had translocated chromosomes and were resistant to these insecticides. Aphids taken from peach in the spring, with normal chromosomes, produced 25-50% mortality, when treated with 100 ppm Malathion.

The degree of these resistance varied with various clones in different experiments. It is generally concluded that green peach aphids clones in Iran were five to ten times more resistant to Malathion. The reason why Malathion is less effective on resistant aphids, as compared to Diazinon, needs further studies.

DETECTION OF HOMOLOGOUS SEQUENCE OF ESTERASE GENE IN INSECTICIDE RESISTANT MOSQUITOES. Qiao-yun Chen, Jia-yu Huang, Na-xin Tu, Jing-wei Tan, Guo-fang Ling, Gen-chun Wang and Jia-liang Jiang (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China) Xiang-fu Wu (Shanghai Institute of Biochemistry, Academia Sinica, Shanghai 200031, China)

Three strains of *Culex pipienes pallens* (C.p.p), dipterex-resistant(Rd), resmethrin-resistant(Py) and susceptible(s) strains, were examined in the present work. The chromosomal DNA was isolated from adult mosquitoes of different strain and digested to completion with EcoRI, BamHI, and HindIII. A cDNA probe (gift from Prof. Mouches) coding part of esterase B1 was used to detect the homologous sequence of esterase gene in genomic DNA of Rd, Py and S mosquitoes. The results showed that a strong hybridization of labeled probe was observed with the fragments in Py DNA, but the Probe cDNA hybridized very slightly with the fragments of Rd and S DNA. We therefore got the following preliminary conclusions: (1) Homologous sequence of esterase B1gene in Tem-R DNA also exists in chromosomal DNA of C.p.p. (2) resistance to resmethrin in Py strain is accompanied by amplification of the homologous sequence which contains at least part of the esterase B1 gene. (3) No correlation was found between production of esterase B1 and resistance to dipterex in C.p.p. species. It is suggested that the molecular mechanism of resistance to dipterex and resmethrin may be different. The increased esterases responsible for resistance in Rd and Py may be produced by different structural gene.

RESISTANCE MECHANISMS IN ACARICIDE-RESISTANT TWO-SPOTTED SPIDER MITE STRAINS. J. Sula, Czechoslovak Academy of Sciences, Institute of Entomology 37005 Ceske Budejovice, Czechoslovakia; **Axel Mueller**, Federal Biological Research Centre for Agriculture and Forestry D/O-1532 Kleinmachnow, Germany; U. Schoknecht and P. Richter, Biological Research Centre Kleinmachnow, Germany

The study of the reason of pesticide resistance in the spider mite Tetranychus urticae led to hereditary fixed changes in the protein pattern of metabolic enzymes and probably receptor proteins. The main resistance mechanism in organophosphate resistant spider mites does not coincide with the mechanism found in strains resistant to chlorinated carbohydrates, where an varied pattern of glutathione dependent transferases seems to be responsible for resistance. In organophosphate-resistant mites an insensitive acetylcholinesterase was detected together with a wide polymorphism of unspecific esterases. The knowledge of the abundance of resistance mechanisms in populations can help in search of useful acaricides. On the base of the biochemical and genetical background it seems to be possible to evolve a strategy for minimizing acaricide treatments.

CYROMAZINE RESISTANCE IN LIRIOMYZA TRIFOLII (BURGESS) (DIPTERA: AGROMYZIDAE). Gary L. Leibee and Kenneth E. Savage (Central Florida Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, 2700 East Celery Avenue, Sanford, Florida 32771, U.S.A)

Cyromazine (N-cyclopropyl-1,3,5-triazine-2,4,6-triamine) is an insect growth regulator currently formulated as Trigard 75WP (Ciba-Geigy) for the control of Liriomyza spp. leafminers in celery and head lettuce in Florida. Unusually heavy infestations of L. trifolii occurred in celery during the use of cyromazine in 1989. Concentration-mortality studies were conducted on a strain originating from the affected area and a strain known to be susceptible to cyromazine.

Results indicated about a 30-fold level of resistance. No cross resistance to abamectin was indicated. Concentration-mortality studies on offspring from reciprocal crosses of the susceptible and resistant strains indicated that the cyromazine resistance was a functionally recessive trait and not sex linked. Backcross studies indicated that the resistance was probably conferred by a major gene.

Insecticide Resistance in the Asian Tiger Mosquito Aedes albopictus in Taiwan. Err-lieh Hsu, Yi-pey Luo (Department of Plant Pathology & Entomology, National Taiwan University, Taipei, Taiwan, China)

Asian tiger mosquito, Aedes albopictus (Skuse) is an important vector of dengue viruses in southern Taiwan since 1981. The epidemic dengue fever was outbreak in 1989 total 10617 cases were reported. The dengue fever has been controlled succesfully by mosquito breeding site removing and chemical spraying only 133 confirmed cases have been reported in 1991. Toxicities of ten commonly used insecticides to the Asian tiger mosquito were determined to learn the current statue of insecticide resistance in this insect in Taiwan. The mosquito larvae were collected from different localities in Taiwan showed no resistance to permethrin, α-cypermethrin, chlorpyrifos, diazinon, dichlorvos and propoxur. However a slight resistant to temephos, fenitrothion, fenthion and malathion (3-5x) were observed. Detoxication enzyme assays exhibited widely individual variations of activities of microsomal aldrin epoxidase, glutathion S-transferase and α-nathyl acetate esterase.

The Current Status of Insecticide Resistance of Brown Planthopper,Nilaparvata lugens Stal, in Taiwan Shun-Cheng Wang(Taiwan Agricultural Chemicals and Toxic Substances Research Institute,Taichung 431,China)

Since 1976, the toxicity of 14 insecticides to brown plant-hoppers collected from rice field in central Taiwan has been periodically minitored by a rice seedling dipping method.LC50 values separartely obtained in 1977-1990 and in 1976 were compared to determined if insecticide resistance had developed during 15 years as a basis on which to make a reference to changes in the resistance of brown planthoppers during the corresponding period. The resistance of brown planthoppers to the test insecticides exhibited flexible flunctution during test period. The level of resistance to organophosphates and carbamtes within 10 folds during the survey periods. It is obviously brown planthopper collected from Taiwan became gradually susceptible to both organophosphates and carbamates insecticides in recent years.

Brown planthopper also developed high resistance level to insect growth regulator (buprofezin) during 1986-1990 survey period. Brown planthopper had developed more higher resistant in southern Taiwan area than central Taiwan area.

FIELD EVALUATION OF INSECTICIDE APPLICATION STRATEGIES ON THE INSECTICIDE RESISTANCE DEVELOPMENT OF THE COLORADO POTATO BEETLE. Zane Smilowitz, Hanwen Huang, Micheal C. Saunders, & Randall Wiesz (Department of Entomology, Penn State University, University Park, PA 16802, USA)

Sequential applications of esfenvalerate, and alternating uses of esfenvalerate, endosulfan, azinphosmethyl, oxamyl and *Bacillus thuringiensis* were evaluated to investigate their influence on the development of insecticide resistance of field populations of the Colorado potato beetle (CPB), *Leptinotarsa decemlineata*. A filter paper technique was used to estimate the dose-mortality relationship for first instar larvae and topical application was used to measure the adult's LD_{50} and LD_{90} of esfenvalerate. Sequential applications of esfenvalerate applied 9 times during the season resulted in a 3.6-fold increase in LC_{50} in resistance to esfenvalerate for first instar larvae, and a 2.7-fold increase in LD_{50} for adults. The resistance ratios for first instar larvae and adult CPB against esfenvalerate were significantly correlated to the frequency of applications in the fields (R^2=0.967 and R^2=0.828, respectively). CPB collected from all fields at the end of the season exhibited 1.2 to 1.5-fold increase in resistance to azinphosmethyl, and 1.6 to 2.0-fold increase in resistance to endosulfan. No significant increase in resistance to oxamyl has been detected.

THE MOLECULAR BASIS OF RESISTANCE TO PYRETHROIDS IN *HELIOTHIS VIRESCENS*. Martin F. J. Taylor (Department of Entomology, University of Arizona, Tucson, AZ 85721, USA)

Pyrethroids, with their lack of persistence and low mammalian toxicity, have been valuable as insecticides since the early 1970's. However, heavy use has selected for resistance to pyrethroids in populations of a major cotton pest in the Americas, *Heliothis virescens*. Several studies have identified the voltage-gated sodium channel as the principal target of action of pyrethroids, and have implicated the sodium channel in resistance. I present evidence that pyrethroid resistance is linked to a sodium channel locus in one strain of *H. virescens*. Further evidence concerning the molecular basis, and population genetics of pyrethroid resistance in field populations will be presented and discussed.

Metabolic Mechanisms and Inheritance for Resistance of Azinphosmethyl and Esfenvalerate in Colorado Potato Beetle (Coleoptera: Chrisomelidae: *Leptinotarsa decemlineata* (Say). J. Huang, Z. Smilowitz, and B. McPheron. Department of Entomology, The Pennsylvania State University, University Park, Pennsylvania, U. S. A.

Influence of synergists (piperonal butoxide, S,S,S-tributylphosphorotrithioate, and Diethyl maleate) on the toxicity of azinphosmethyl and esfenvalerate was studied on four field populations of Colorado potato beetle from three counties in Pennsylvania. The synergists significantly decreased the LD50's of azinphosmethyl and esfenvalerate of adults and larvae of all the above populations. Piperonal butoxide was the most effective synergist, followed by S,S,S-tributylphosphorotrithioate. These results would indicate that mixed-function oxidases are primarily responsible for resistance in these two insecticides, esterases also play an role .

Reciprocal crosses were made to study the inheritance of resistance of azinphosmethyl and esfenvalerate in Colorado potato beetle. Azinphosmethyl and esfenvalerate resistance strains were crossed to laboratory susceptible strains. Results of reciprocal crosses indicated that the resistance factors are transmitted to the hybrids by either the male or the female parent. This would indicate that the resistance factors must be located on the autosomes. The degree of dominance of all strains are negative. These would imply an autosomal, incomplete recessive form of inheritance for resistance to these insecticides.

Repeated backcrossings were used to create an isogenic strain and isolate the major resistance gene that influences the resistance phenotype. Toxical results of F2 and repeated backcrossings were used to determine wether a single gene or multiple genes influence insecticide resistance.

INSECTICIDE RESISTANCE MANAGEMENT: IT'S ROLE AND IMPACT ON THE FUTURE OF INSECT CONTROL. Steven L. Riley, David A. Marsden, William P.N. Lau, S.H. Chang, Harry H. Harder (Du Pont China Ltd 1122, New world office Building (East Wing) Hong Kong)

Insect resistance to insecticides is a major factor that influences the discovery, development, use and life of products. The increasing costs of insect control technology and crop production make it critical that we attempt to clearly assess the risk of resistance to new discoveries and manage it's development once a product enters the marketplace. Risk assessment programs are valuable during the discovery and early development of new products and technologies. Their goal should not only be to evaluate the potential of a new product, but also to build early stage monitoring and efficacy information on geographic strains. To ensure the success of new products, they should be introduced under resistance or stewardship programs within local Integrated Pest Management (IPM) programs. In many cases this will require new labelling, an increased understanding of local host-insect complexes and close interactions between industry, government, academia and growers.

GLUTAMATE RECEPTORS AS SITES FOR THE DEVELOPMENT OF INSECT SPECIFIC TOXICANTS. Peter N R Usherwood, Department of Life Science, University of Nottingham, Nottingham NG7 2RD, U.K.

When the concept of "the rational design of insecticides" was first mooted the glutamate receptors of insect central nervous systems and muscle seemed obvious examples of signalling proteins which could be targeted. However, although subsequent intensive research has engendered a major increase in our understanding of their pharmacological and physiological properties, these receptors have proved to be difficult subjects for the applied scientist. Many of the most successful insecticides disrupt insect cholinergic synapses by inhibiting acetylcholinesterase. However, insect glutamatergic synapses do not contain an enzyme equivalent in function to acetylcholinesterase; transmitter glutamate is removed from these synapses by diffusion and uptake into surrounding tissues. It is unlikely that blockers of glutamate uptake systems can be designed specifically to target insects. It may be possible to block specifically the release of transmitter from insect glutamatergic neurones using toxins (e.g. *Habrobracon* toxin). Alternatively, through either competitive or non-competitive antagonism of the postjunctional glutamate receptors at these synapses it may be possible to develop new classes of pesticide. Of course, glutamate receptors are not found exclusively in insects, but it is possible that the pharmacological properties of insect glutamate receptors are sufficiently distinct to make the design of insect-specific glutamate receptor antagonists a possibility. With this latter idea in mind the polyamine-containing toxins of certain wasps and spiders have been extensively investigated by a number of groups. The results of these investigations will be summarised with an eye to future developments in this field.

EFFECT OF INSECT GROWTH REGULATORS ON CHILOCORUS NIGRITUS (F.), A COCCINELLID PREDATOR OF AONIDIELLA AURANTII (MASK.). M.M. CLARK (Outspan Citrus Centre, Nelspruit 1200, South Africa).

The effect of buprofezin (0.015% a.i.) and pyriproxyfen (0.003% a.i.), used to control California red scale (Aonidiella aurantii [Mask.]), and teflubenzuron (0.006% a.i.) and triflumuron (0.009% a.i.), used to control false codling moth (Cryptophlebia leucotreta Meyr.), was investigated on Chilocorus nigritus (F.). C. nigritus is an effective predator of high population densities of California red scale in southern Africa. Eggs laid by fertilized C. nigritus females failed to hatch while on a diet of oleander scale (Aspidiotus nerii Bouché) treated with the above IGRs. All the females were then fed untreated oleander scale. A few of the eggs then laid by females fed previously on oleander scale treated with buprofezin, teflubenzuron and triflumuron hatched. None of the eggs laid by females previously on a diet of oleander scale treated with pyriproxyfen, hatched. Orchard observations generally confirm these results. However, no California red scale outbreaks have been reported after the use of the above IGRs, probably because the hymenopterous parasitoids, which are unaffected, have maintained effective control of the populations.

ELECTROPHYSIOLOGICAL EFFECTS OF SPILANTHOL ON SINGLE NEURONS IN THE SIXTH ABDOMINAL GANGLION OF *PERIPLANETA AMERICANA* L. Abdul A. Kechil, Habsah A. Kadir (Department of Zoology, University of Malaya, 59100, Malaysia), Muhamad B. Zakaria (Department of Botany, University of Malaya, 59100 Kuala Lumpur, Malaysia).

N-isobutyl-2,6,8-decatrienamide (spilanthol), a bioactive component of *Spilanthes acmella* Murr. (Compositae) extracts was the most potent compound when compared to bioresmethrin, carbaryl and lindane, against American cockroach, *Periplaneta americana* L. Extracellular electrophysiological study has shown that spilanthol can cause immediate hyperexcitation followed by complete inhibition of the cockroach cercal nerve activity. The mechanism of neurotoxic action of spilanthol was elucidated using intracellular microelectrode recording technique on individual neurones in the sixth abdominal ganglion of the American cockroach and analyzed by phase plane portrait technique. The results show that spilanthol caused periodic bursts of spike potential with a train of impulses in the central neurons. It also modified the action potential trajectory (i.e. spike potential shape) and altered the shape of the phase portraits of these neurones, suggesting that the mechanism of action of spilanthol as a neurotoxin is likely to be on the sodium channels of the nerve membrane.

HOMMAGE TO SOME PIONEERS INVOLVED IN THE DISCOVERY OF INSECT JUVENILE HORMONE 25 YEARS AGO. Hans E. Hummel, Institute of Phytopathology and Applied Zoology, Biological and Biotechnical Plant Protection, Justus-Liebig-University, Ludwigstrasse 21 b, D-6300 Giessen - Germany -

A short communication by Röller, Dahm, Sweely, and Trost (1967) titled: "The structure of the juvenile hormone" appeared a quarter of a century ago in Angew. Chem. Int. Ed. Engl. 6: 179-180.

Röller's group of young pioneers combining efforts from the University of Wisconsin, Madison, USA, succeeded in the structure elucidation and spectrometric confirmation of the long sought insect juvenile hormone, today known as JH-I. The 19th International Congress of Entomology offers the welcome opportunity for celebrating this outstanding scientific contribution.

The discovery of JH-I paved the way for an immense international research effort culminating in the isolation and identification of 3 more naturally occuring homologs, JH-0, JH-II and JH-III, mostly within the next decade; in many symposia and proceedings, and in the industrial development and application of several synthetic analogs for the control of medically, veterinarily and agriculturally important insect pests and parasites.

Röller et al.'s seminal paper focussed a large segment of entomological and endocrinological literature and helped unravel and understand the hierarchically structured web of isoprenoid, peptidic and proteinaceous hormones, releasing factors and gonadotropic substances known in arthropods today.

ZERO BACKGROUND SCE IN SOME MOSQUITO CELLS. L.Y. Wei (Division of Palnning and Evaluation, National Science Council, Taiwan 10636., China), Roger F.N. Hou (Dept. Entomol., Chung-Hsing University), K.Y. Jan and T.C. Wang (Inst. Zool., Academia Sinica, Taipei 11529, China)

Available evidence indicate that a background level of SCE exists in mammalian cells. However, in the somatic cells of Drosophila melanogaster, there is no spontaneous SCE if minimum concentration of bromodeoxyuridine (BrdU) is used. In this communication we report that in mosquito (Aedes aloopictus) cell line (C6/36), some cells also have no background SCE. Lines of high or low frequency of 0-SCE cells were obtained by recloning, however subclones with 100% 0-SCE cells was not obtained. Increasing frequency of SCE/cell concomitant with decreasing frequency of 0-SCE cells was observed by raising the BrdU concentration in culture medium especially during the first cell cycle, culturing cells in low density, depleting cellular glutathione by the treatment of buthione sulfoximine. Since these mosquito cells contain much higher level of glutathione than human fibroblasts or Chinese hamster ovary cells, we suspect that the high glutathione may be responsible for their low or none background SCE and high resistance to many DNA damaging agents.

TEBUFENPYRAD : A NEW ACARICIDE COMPATIBLE WITH INTEGRATED MITE CONTROL ON APPLE. Colin C. Bower, W.G. Thwaite, D. Swist-Swirski, A. Hately (Agricultural Research and Veterinary Centre, Forest Road, Orange, NSW 2800 Australia)

Tebufenpyrad is a new acaricide discovered by the Mitsubishi Kasei Corporation. It is being developed in Australia by Sandoz Australia Pty Ltd for control of twospotted mite, *Tetranychus urticae* Koch and European red mite, *Panonychus ulmi* (Koch) on pome fruit. Laboratory bioassays of tebufenpyrad against four strains of adult female *P. ulmi* provided baseline toxicity data showing it to be highly active. More limited bioassays also showed tebufenpyrad is toxic to the predatory mites, *Typhlodromus occidentalis* Nesbitt and *T. pyri* Scheuten, which form the basis of integrated mite control (IMC) programs in NSW. However, the data suggests it is less toxic to the predators than to *P. ulmi*. Four field trials, each using four concentrations of tebufenpyrad (10, 7.5, 5 and 2.5 g a.i. per 100 L) showed it is selectively more toxic to the pest mites than to predators and is compatible with IMC. It is suggested that a concentration of 5 g a.i. per 100 L would be suitable for IMC. A resistance management strategy for tebufenpyrad is proposed.

STABILIZING IMPORTANT AGROECOSYSTEMS: THE CONTRIBUTION OF JUVENOIDS.
Dorn, Silvia (Dr R. MAAG LTD, CH-8157 Dielsdorf, Switzerland)

A 2 year ecological study of an apple orchard in Japan compared the effects of a juvenoid, fenoxycarb, with those of a standard broad-spectrum neurotoxin, nicotine sulfate.
The target pest Phyllonorycter blancardella was well controlled by both products. The efficacy of fenoxycarb was complemented by native populations of hymenopterous endoparasites, Holocothorax testaceipes and Apanteles kuwayamai. This resulted in an overall lower pest population as compared to the standard plot, persisting on even into the following season.

A multidisciplinary study in a vineyard in Switzerland compared the effect of fenoxycarb with a standard organophosphate, etrimphos, on the primary target target pest, Lobesia botrana, and the associated fungal disease, Botrytis cinerea.
The pest insect population was maintained below the economic damage threshold by both products. Due to its particular mode of action fenoxycarb resulted in a lower infestation level of the fungal disease.

The potential of juvenoids for stabilizing agroecosystems is discussed with reference to further studies. They show in particular that the selective control of chewing pests by fenoxycarb allows in many instances a natural control of sucking pests.

BIOACTIVITIES OF BENZOYLPHENYL UREAS ON RICE LEAF FOLDER (CNAPHALOCROCIS MEDINALIS) Wen-liang Pan(Plant Protection Institute, Hebei Academy of Agriculture and Forestry, Baoding 071000, China) Shin-foon Chiu(South China Agricultural University, Guangzhou 510642, China)

The bioactivities of 6 benzoylphenyl urea insecticides on different developing stages of rice leaf folder(Cnaphalocrocis medinalis) were tested and reported in the present paper. Dipping the leaf folder eggs in solutions of the benzoylphenyl ureas, XRD-473, flufenoxuron and teflubenzuron considerably inhibited the egg hatching. By feeding the different instar larvae of the leaf folder with rice leaves spraying-treated with different concentrations of the benzoylphenyl ureas, LC50s of 5 insecticides were determined, and chlorfluazuron, XRD-473 and flufenoxuron showed strong toxicities against all instar-larvae. By feeding the newly emerged rice leaf folder adults with 20ppm of the benzoylphenyl ureas mixed in 5% sucrose solution, the adults treated with chlorfluazuron, XRD-473, teflubenzuron, flufenoxuron and diflubenzuron laid less eggs than the untreated ones. Morever, the hatching rates of eggs laid by treated adults were also considerably reduced.

BIOLOGICAL ACTIVITY AND MODE OF ACTION OF BUPROFEZIN ON THE BROWN PLANT HOPPER, NILAPARVATA LUGENS STAL, XIANJIN LIU, CHENG-WEN DU (Institute of plant protection, Jiangsu Academy of Agricultural Sciences, Nanjing 210014 , China)

Buprofezin has very high biological activity on the brown plant hopper, Nilaparvata lugens, stal. Results of biological tests and GC analysis showed that buprofezin can be obsorbed by rice leaf and leaf sheath, and shifted partially from leaf to leaf sheath. Histological examination and electron microscopic inspection of nymphs reared for 72 hrs on the buprofezin treated rice plants revealed blocking of the formation of the endocuticular tissue, resulting in an amophous cuticular region instead of the nomal lemellae cuticle deposition patterns.The inhibition of the prophenol oxidase activity of the intigument suggested the quinone-tanning process of the treated nymphs was affected. RIA test showed the amount of ecdysteroids of the treated nymphs 48 hrs after moulting increased to 140-150% that of the control.These results suggested that buprofezin disrupted the hormones balance and destroyed the cuticle formation.

EFFECT OF SOLAR RADIATION ON THE DEGRADATION AND MINERALISATION OF ^{14}C- MANCOZEB IN SOIL. Uday Kumar and H.C.Agarwal (Department of Zoology,University of Delhi, Delhi-110 007,India)
The effect of solar radiation on the degradation and mineralisation of ^{14}C-mancozeb fungicide in soil under aerobic and anaerobic conditions was investigated. The sunlight was found to greatly affect the degradation of this fungicide. The overall impact on the mineralisation was however quite different in case of flooded/anaerobic conditions as compared to unflooded/aerobic conditions. Under anaerobic conditions mineralisation was appreciably enhanced by sunlight, as $^{14}CO_2$ evolution in the samples exposed to ultraviolet plus visible light was four times as much as that in dark. Under aerobic conditions the mineralisation of ^{14}C-mancozeb was reduced on exposure to visible light. Ultraviolet light reduced it further. The reduction in the rate of mineralisation in the samples exposed to ultraviolet light may be due to decreased microbial activity. Both microbial action and solar radiation were the major factors responsible for mineralisation. ETU was the major metabolite of ^{14}C-mancozeb. Under anaerobic conditions 27.48 ppm ETU was detected in soil exposed to ultraviolet and visible light, whereas under aerobic conditions the corresponding value for ETU was 7.83 ppm.

AN APPROACH TO THE IPM OF THE DIAMONDBACK MOTH IN THAILAND
Tetsuo Saito,Tadashi Miyata(Faculty of Agriculture, Nagoya University,Chikusa,Nagoya,Japan),Neungpanich Sinchaisri,Ouab Sarnthoy(Department of Entomology, (Kasetsart University,Bangkok 10900,Thailand),Anan Vattanatangum,Winai Rushtapakorncahi,Piyarat Kienmeesuke(Department of Agriculture,Bangkok 10900,Thailand)

Diamondback moth has distinctive biological and physiological characteristics,short life cycle,high fecundity,short larval and long mature periods,high adaptability to diferent climates,relative wide host range,attack to vegetable sprout,attack to cash crops, neumerous natural enemies by key ones are few,high adaptability to pesticide selection,long-distance migration. Thereore,resistance to insecticides in the diamondback moth is most serious problem for control of this insect.

We had developed several technologies for an approach to the IPM in the diamondback moth,mass rearing,insecticides resistance monitoring,intermediate insecticide bioassy,selective toxicity between the diamondback moth and natural enemy,yellow sticky trap for use partially control and forcasting of population density,netting and model ecosystem.

THE USE OF CHEMICALS FOR THE CONTROL OF LIVESTOCK TICKS IN AFRICA. A.O.J. Amoo (The International Centre of Insect Physiology and Ecology, P.O. Box 30772, Nairobi, Kenya)

Studies aimed at determining cost effective regeimes of acaricide application at three different farming methods at the Coast Province of Kenya have shown that cattle, either weaners, dairy or beef can be kept highly productive without the use of acaricides on an intensive basis. The weight increase of weaner animals subjected to weekly dipping regime was 43% as compared to approximately 100% for those under relaxed dipping regimes of fortnightly and monthly. Milk production of dairy cattle in various regimes of dipping were not significantly differentl from each other, despite the increased costs of dipping weekly in the control group. For the beef cattle, there was significantly higher profit/animal in those subjected to fortnightly, monthly and once every six-weeks regimes of dipping. For all cattle types, no marginal benefits accrued to intensive weekly dipping as compared to any of the other groups. It is concluded that intensive acaricide application for tick control is not cost effective, as exposure to a certain level of infestation leads to the development of resistance to ticks and hence to tick-borne diseases.

EVALUATION OF FENOXYCARB, FOR ARMOURED SCALE CONTROL ON KIWIFRUIT. A.R. Tomkins, C. Thomson (MAF Technology, Ruakura Agricultural Centre, Private Bag, Hamilton, New Zealand)

Armoured scale insects, particularly greedy scale (Hemiberlesia rapax) are key pests of kiwifruit (Actinidia deliciosa) grown commercially in New Zealand. Currently control of greedy scale relies on regular applications of broad-spectrum insecticides. Using these insecticides has the undesirable side-effect of hindering parasitoids from assisting with the control of greedy scale. Alternative insecticides with less harmful effects on biological control agents are therefore being evaluated. The insect growth regulator fenoxycarb showed promise based on studies with other species of armoured scale insects and was evaluated under laboratory and field conditions. Laboratory trials demonstrated that fenoxycarb had good activity against greedy scale although some harmful effects on a parasitoid were also found. In a series of field trials, fenoxycarb was compared with the organophosphate insecticide phosmet. Regular monitoring of greedy scale infestation of kiwifruit vine leaves showed that regular applications of fenoxycarb killed many greedy scale during moulting between the second and third instar confirming the results of laboratory studies. Although applications of fenoxycarb resulted in a reduction in the level of leaf and fruit infestation the level of greedy scale control achieved was lower than that with phosmet.

THE FATE OF HAEMOCYTES OF APHIDOPHAGOUS SYRPHID FLIES (*EPISYRPHUS BALTEATUS* DCG.) BY THE TREATMENT WITH PIRIMOR. T. T. Mahmoud (Mosal University, Iraq)

The changes in haemocytes of the larvae of syrphids were studied after the treatment with 100 ppm (sub-lethal dose) pirimor DP50. New shape of prohaemocyte was observed in 24 hours old 3rd instar larvae for the first time, meanwhile severe damage of plasmatocytes was noticed within 24 hours after treatment. New shapes of transitional plasmatocytes were found for the first time within 72 hours old 3rd instar which indicated that new generation was developed. Heavy injuries of granular cells were observed within 72 hours old 1st instar and 24 hours old 2nd instar. Transitional granular appeared in 48 hours old 3rd instar larvae for the first time, while the mature granular cells appeared normal during the last 2 days of the life cycle of the larvae. Abnormality of podocytes was noticed 48 hours after treatment in 2nd instar. Transitional shapes were observed for the first time within 72 hours old of 3rd instar. The shape of new generation of podocytes was appeared in the last 48 hours of the life cycle of the larvae. Spherule cell appeared abnormally in 72 hours of the 3rd instar, while the changes in the crystal cells were observed in 2nd instar, meanwhile changes happened in the oenocytoide; many vacuole with scattered inclusions were found after 96 hours of treatment within 3 day of the 2nd instar larvae.

THE EFFICACY OF A NEW ACYLUREA INSECTICIDE ON CULEX PIPIENS PALLENS LARVA. Shixiong Wu, Jingfeng Chen (Institute of Inspection of Agrochemicals, Ministry of Agriculture, Beijing 100026, China) Chenxi Sun. Zunlan Fan(Tianjin Hygiene and Disease Prevention Centre, Tianjin 300011, China)

The excellent efficacy of cascade on eggs, 2nd or 4th instar larvae and pupae of mosquito has been confirmed both in the lab and in the field. The results in the lab showed that 1. Cascade had a significant inhibitory action to the egg hatching rate persistance at the dosage of 2, 1, 0.1, 0.05 ppm with the persistance duration of 17 days. The larvae hatched were mostly killed at the same dosage. 2. The persistance duration for 2nd instar larvae with 100% mortality was 16 weeks (0.05ppm, 0.1ppm), 29 weeks (1ppm) and 35 weeks (2ppm) respectively. The persistance duration for 4th instar larvae with 100% mortality was 1 week (0.05ppm), 7 weeks (0.1ppm), 11 weeks (1ppm, 2ppm) and 14 weeks (with 94% mortality, 2ppm) respectively. 3. It also gave a good inhibition to the emergence, and the mosquitoes emergened were mostly be killed at the same dosage. The mosquitoes can be killed at the dosage of 0.5, 1, 2 ppm in the field. The larvae could be controlled under 2nd instar and killed at the above dosages within 106 days.

THE INTELLIGENT USE OF PESTICIDE MIXTURES: CONSTRAINTS AND BENEFITS. G.H. Ernst,(Plant Protection Division, CIBA-GEIGY AG CH 40002 Basel, Switzerland.)

Mixtures may be applied to optimize the use of insect control agents with respect to selectivity, environmental impacts, economy, and resistance problems. In practice, mixtures are widely used for economic and practical reasons. The danger of unintended combination effects by mixing any control agents (cocktails) could lead to situations which are not advantageous to the farmer. To avoid this, the efficacy of mixtures should be investigated on the local insect population and local conditions to estimate the possible benefits such as potentiation, economy, and safety . Ready to use mixture formulations are advised for the small farmer .

SELECTIVE ACETYLOCHOLINESTERASE INHIBITION KINETICS IN DYSDERCUS KOENIGII (F.) AND ITS ENEMIES. R.K. Tripathi, H.K. Singh and H.N. Singh (Institute of Agril. Sciences, Banaras Hindu University, Varanasi - 221 005, India).

Acetylcholinesterase (AChE) from cotton stainer, Dysdercus koenigii (F.), its predator, Antilochus coquerberti F. and a tachnid parasite, Besserioides sp. showed significant difference in pS optima (2.5 fold) and Vmax (12.4 fold) for acetylthiocholine hydrolysis. In vitro inhibition with seven structurally analogous phosphates, one thionophosphate and carbaryl showed higher AChE sensitivity (I_{50}) in prey than predator ranging from 1.19 fold with mevinphos to 10.51 fold with dichlorvos. Inhibitor poteney (Ki) of carbaryl was 3.88 times lower for parasite than the host. Lower enzyme-inhibitor affinity (Ka) accounted for the increased Ki in most of the cases but mevinphos, tetrachlorvinphos and monocrotophos in cotton stainer; dichlorvos in predator and tetrachlorvinphos and dichrotophos in parasite showed higher Ki owing to the higher phosphorylation rate (Kp). Lc_{50} data for the stainer showed the similar toxicity order with 5 of these compounds. This indicates scope of evolving specific chemicals safer to beneficial fauna.

CHEMICAL TOXICITY OF PESTICIDES AND THEIR ENVIROMENTAL PROBLEMS IN DEVELOPING COUNTRIES : THE NIGERIAN EXPERIENCE. Y.A. Issa. (Federal Department of Pest Control Services P.M.B. 5672, Moor Plantation, Ibadan, NIGERIA.)

Pesticides vary widely in their toxicity to human beings depending among other factors, on the route through which they gain access into the body. Pesticides may cause irritation, Inflamation of the eyes, skin or the respiratory tract when swallowed, inhaled or absorbed through the skin.

It is important to know that the enviromental hazard, a pesticide may represent, is not only related to the toxicity with respect to various taxonomic groups of organisms, but also depend strongly on the likelihood that non-target organisms and the enviromental factos such as air, soil, water etc will get exposed to a toxic dose.

#1

BIFENTHRIN RESIDUES IN ORANGES DETERMINED BY GAS CHROMATOGRAPHY. Batista, G.C. de (Department of Entomology, ESALQ/USP, 13400 Piracicaba-SP, Brazil), G. Papa, M.L.S. Fustaino (FMC do Brasil Ltda., Av. Dr. Moraes Sales, 711, 13010 Campinas-SP, Brazil).

The purpose of this research was to evaluate the occurence and persistence of bifenthrin residues in oranges, after the use of the insecticide/miticide for control of mites.

Treatments were replicated three times with dosages (g a.i./ha) of the following: A 0 (control); B 25; C 37.5; D 50; E 75 and F 100, being the pesticide used in one spray application. Samples were collected at 1, 3, 7 and 10 days after spraying; 72 samples were analysed.

Samples were extracted with acetone; clean-up of the extracts was made through a Florisil column, and elution accomplished with a mixture of hexane/methyl-t-butyl ether. Quantitative estimates were determined in a gas chromatograph equipped with an electron capture detector (Ni^{63}). The detection limit of the method was 0.01 mg/kg (ppm), and the recovery 86 ± 4%.

Residues were detected through the entire sampling period in E and F treatments (maximum values of 0.08 and 0.15 ppm, respectively), being reduced to 1/4 of its initial deposits. All other samples indicated no detectable residues (below 0.01 ppm) before the end of collecting period.

Maximum residue level (tolerance) for bifenthrin in citrus is 0.04 mg/kg (ppm); safety interval established by legislation is 7 days. At recommended dosage (36 g a.i./ha) bifenthrin residues in citrus after safety interval were below tolerance level.

#2

TOXIC CONTAMINATION (PESTICIDES AND PCB) OF ORTHOPTERA (ACRIDIDAE, TETTIGONIIDAE) OF STEPPE ZONE OF KAZAKHSTAN. S.R. Nasyrova, V.I. Nilov (Institute of Zoology, Academy of Kazakhstan, Alma-Ata 480032, Kazakhstan)

For studying of content of chlororganic compounds (COC, getting into biosphere as pesticides DDT, HCCH and technological wasts-polychlorbifeniles-PCB) in organisms of Othoptera the locusts and grasshoppers of 7 common species were analyzed in the region of intensive agricultural and industrial production (Ural Area). Content of COC was determined on chromatograph "Chrom-5" with detector of the electronic seizure. Its sensitiveness was 0.001mg. The highest content of DDT+HCCH metabolites combination was in phytotrophic locusts: 34.3-173.7 mcg/kg in *Pararcyptera microptera* to 422.3-594.7 mcg/kg in *Stenobothrus eurasius*. In geterotrophic grasshoppers the concentration DDT+HCCH was fluctuated from 136.8 in *Tettigonia caudata* to 200 mcg/kg in *Montana eversmanni*. The concentration of PCB was higher in locusts; from 26,856 in *S. eurasius* to 55,156 mcg/kg in *P. microptera* and in grasshoppers (*M. eversmanni, T. caudata*) the PCB was marked from 39285 to 48671 mcg/kg. The prevalens of high-chlorinate PCB was noticed, whereas in vegetation and soil samples there only low-chlorinate PCBbymore concentrations.The accumulation of COC metabolites in orthopterans, which follows from their high concentrations being higher than those in vegetation and soil, is dangerous for both insects and their predators. These compounds possess chronic effect, that is the prolonged influence of small doses, which can affect on the state of both population and ecosystem as a whale.

#3

TOXICITY AND ACTION OF DIAFENTHIURON IN DIAMONDBACK MOTHS. Habsah A. Kadir (Department of Zoology, University of Malaya, 59100 Kuala Lumpur, Malaysia), Charles O. Knowles (Department of Entomology, University of Missouri, Columbia, MO 65211, U.S.A.)

Diafenthiuron, a thiourea acaricide/insecticide, was toxic when applied topically to adult diamondback moths (DBM), *Plutella xylostella* (L.); however, DFCD, its carbodiimide metabolite was more toxic to DBM than diafenthiuron. Treatment with piperonyl butoxide protected against the lethal action of diafenthiuron but not that of DFCD. Theophylline, synergized the toxicity of diafenthiuron and DFCD to DBM. Signs of poisoning in DBM treated with either compound were time and dose dependent and appeared earlier and with greater intensity in moths treated with DFCD. Signs included hyperreflexia and hyperactivity and were similar to those elicited by demethylchlordimeform. DFCD, but not diafenthiuron, stimulated adenylate cyclase activity in homogenates of DBM heads. Both octopamine- and dopamine-sensitive adenylate cyclases were present, and the data suggested that DFCD was binding to both enzymes. It was concluded that actions of DFCD on these biogenic amine-sensitive adenylate cyclases likely were involved in the toxicity of diafenthiuron to DBM.

#4

METABOLIC ACTIVATION OF S,S,S-TRIBUTYL PHOSPHOROTRITHIOATE AS AN INHIBITOR OF ACETYL- AND BUTYRYL-CHOLINESTERASE. J.H. Hur*, S.Y. Wu and J.E. Casida (Pesticide Chemistry and Toxicology Laboratory, Department of Entomological Sciences, University of California, Berkeley, CA 94720, U.S.A)

S,S,S-Tributyl phosphorotrithioate is a cotton defoliant known as DEF and is also active as an insecticide synergist and delayed neurotoxicant. It was examined as a model for the oxidative bioactivation of phosphorothiolate pesticides in general. The potency of DEF as an inhibitor of acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE) is increased 1000 and 10 fold, respectively, when DEF and the esterase are incubated with microsomes fortified with NADPH compared with microsomes alone. These activation reactions are inhibited by piperonyl butoxide (PB) providing further evidence for the involvement of cytochrome P_{450}-dependent oxidases. PB does not suppress in vivo DEF-induced inhibition of BuChE in plasma but enhances that of AChE in erythrocytes. Many liver cytosolic esterases are inhibited by DEF administered IP to mice at 1-100 mg/kg with PB suppression of some of the inhibition. Labeling of AChE by [3,4-$^3H_2$-butyl]DEF is enhanced by coincubation with microsomes and NADPH; PB inhibits this bioactivated phosphorylation. Major metabolism of DEF in rats gives S,S-dibutyl phosphorotrithioic acid and S,S-dibutyl phosphorodithioic acid indicating that metabolism involves cleavage of the S-C and P-S bonds, respectively.

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#5

INFLUENCE OF DELTAMETHRIN ON MICROSOMAL CYTOCHROME P-450 ACTIVITY OF SUSCEPTIBLE HOUSE FLIES (*MUSCA DOMESTICA* VICINA L.) **Xin-fu Leng and Jun-yong Huang** (Department of pesticide chemistry and Toxicology, Institute of Zoology, Academia Sinica, Beijing 100080, China)

This paper deals with the effect of deltamethrin on the microsomal cytochrome P-450 of female susceptible house flies (*M. domestica* vicina). The microsomal cytochrome P-450 content (nmol/mg Pr.) of house fly abdomen was significantly induced by treatment with 0.98 ul abdomen of deltamethrin ($5*10^{-7}$ mol/l, in acetone) for 8 and 24 hours. From the results of experiments with different concentrations, it showed that the higher the concentration of deltamethrin, the stronger the effect of induction. When the house flies were treated successively with lower doses for two days, the microsomal cytochrome P-450 contents were also obviously induced. There was no change in the CO-difference spectrum of cytochrome P-450 (max:451nm) in the induced groups and in comparison with the control.

#6

TOXICITY OF CERTAIN PESTICIDES TO APIS CERANA F. FORAGING ON BALSAMINA IMPATIENS. Anita Menon and C.C. Reddy, Department of Zoology (Apiculture Research laboratory), Bangalore University, Bangalore-560056, INDIA.

The residual contact toxicity of a few insecticides to Apis cerana F. forages sprayed on Balsamina impatiens was assessed by a simple laboratory method during 1989-90. Foragers were collected and exposed to the specific pesticide for a fixed period and later transferred to clean cages. Observations and mortality counts were recorded at definite time intervals for 72 hours. With this criterion the percentage mortality in case of Methyl Parathion increased steadily with increasing time. While in the case of Fenvalerate, Carbaryl and Chlordane, there was an increase after six hours showing a low speed of action.

#7

TOXIC EFFECT OF DIFLUBENZURON ON THE FOOD UTILIZATION EFFICIENCY OF GRASSHOPPER (*POECILOCERUS PICTUS*) (ORTHOPTERA: PYRGOMORPHIADAE). P. Somasundaram, S. Chockalingam (Zoological Research Laboratory), Thiagarajar College, Madurai 625 009, India)

The grasshopper *Poecilocerus pictus* causes heavy damage to many economically important crops. An investigation on the effect of oral administration of sublethal dose of diflubenzuron on the feeding budget in the sixth nymphal instar of *P. pictus* has been undertaken. A significant change in the consumption, growth and rate of consumption of diflubenzurum treated leaves was observed ($P<0.001$). The consumption rate was more in control nymphal instar (254 mg/of live wt/day) and reduced significantly in 55 ppm fed nymphal instar (101 mg/g live wt/day). The growth of *P. pictus* was also significantly declined from 249 mg in control to 95 mg in 55 ppm diflubenzuron treated leaves fed group. Not only the growth was inhibited but the ecloded adults showed morphological deformities. The effect of this pesticide in hampering digestion growth and causing crippling of the insect is well documented in this study.

#8

OBSERVATIONS ON THE EFFECTS OF ULTRASONIC FOGGING OF PYRETHROIDS ON INDOOR MOSQUITOES AND FLIES. Wang-cai Cui, Wu-yang Miao, Fu-shuang Lü, Guo-xin Shu (Institute of Microbiology and Epidemiology, Beijing 100071, China)

A satisfactory result has been achieved with ultrasonic fogging of pyrethroids against indoor mosquitoes and flies. The knockdown rate (30 min.) was 96.1-99.0%, and the mortality (24hr.) was 100%, to Culex pipiens pallens when the pyrethroids were used in a dosage of 2.4 mg.a.i/m^3(in 0.64 ml/m^3); while 84.1-100% knockdown rate and 100% mortality were observed to Musca domestica after the same periods of time mentioned above when a dosage of 3.6 mg.a.i/m^3(in 0.96 ml/m^3) was used. A retrenchment by 1/3 of used insecticides, either by reducing the volume of liquids applied or by decreasing the active ingredient involved would result in an impairment of the effectiveness to flies.

#9

KINETICS OF ORGANOPHOSPHORUS PESTICIDE INHIBITION OF ACETYLCHOLINESTERASE FROM HEAD OF *TRYPORYZA NIVELLA* (LEPIDOPTERA: PYRALIDAE). G. C. Pandey (Toxicol. Lab., Dept. of Zoology, K.S.S.P.G. College, Faizabad 224001, U.P., India)

Kinetic constants of inhibition of *Tryporyza nivella* (F.) head acetylcholinesterase by P-O containing OP (Trichlorfen) and P-S containing (Phorate, Malathion, Diazinon) OP were determined. The molecular reaction constant (K_i) did not change appreciably with change in dose of each pesticides. The affinity constants (K_d) of these pesticides were found to be relatively stable at different doses. The phosphorylation constant (K_2) of Trichlorfen was lower than Phorate followed by Malathion and Diazinon, the latter two belonging to same order of magnitude. Since both P-O and P-S compounds had similar affinity constant it is possible that in case of *T. nivella* these compounds in addition to binding with anionic site may also be binding to the hydrophobic site. Pesticides having higher K_i values were found to be generally more toxic.

#10

EFFECTS OF HOST PLANT ON CHARACTERISTICS OF ACETYLCHOLINESTERASES IN APHIS GOSSYPII GLOV. Xi-wu Gao, Bing-zong Zheng(Department of Plant Protection, Beijing Agricultural University, Beijing)

The effects of food plant on acetylcholinesterase (AChE) were investigated in cotton aphids, Aphis gossypii Glov.. In the seven cotton varieties tested, the specific activity of AChE from the aphids fed BR-S-10 cotton leaves was the highest. It was 4.6-fold higher as compared to the specific activity of AChE from the aphids fed Jingyang chicken foot cotton leaves. In the cotton aphid cology reared on the BR-S-10 cotton leaves, the specific activity of AChE of 80.3% of individuals was more than 120 umol/mg protein, min, however, in the coloies fed Chinese cotton 12, PRA51, Fangying shuangwu, No toxin151 and BPA68 varieties leaves, the specific activities of AChEs of only 5.9-32.1% of individuals were more than 120 umol/mg protein,min. The percentages of AChE activities inhibited by omethoate were significantly different in the colonies fed seven cotton varieties. The persentage of AChE activity inhibited in the colony fed BPA68 cotton leaves was 3.7-fold smaller as compared to that in the colony fed Fangyingshuangwu cotton leaves. The individuals whose percentages of AChEs inhibited weremore than 50% were 17,36.6,45.5,52.9,59.0 and 63.3% in the colonies fed BPA68, Chinese cotton 12, BR-S-10, PRA51, No toxin 151 and Fangyingshuangwu, respectively.

#11

EFFECTS OF DELTAMETHRIN ON THE VITELLOGENESIS OF CULEX PIPIENS PALLENS. Yan-de Dong, Rui-de Xue, et al (Institute of Microbiology and Epidemiology, Beijing 100071, China)

The changes of the total RNA of fat bodies and of the vitellin of blood-fed mosquito, Culex pipiens pallens, treated with deltamethrin were observed in laboratory. The composition of vitellin in normal and in treated mosquitoes was studied with SDS-polyacrylamide gel electrophoresis (SDS-PAGE) and thin layer scan techniques. The results showed that the deltamethrin treatment had no effect either on the composition of vitellin or on the total RNA of fat bodies in the process of vitellogenesis, but had an inhibitory influence to the synthesis of vitellin of mosquitoes.

#12

RELATIONSHIP BETWEEN THE ACTIVITY OF MIXED-FUNCTION OXIDASES AND THE TOLERANCE TO INSECTICIDES IN THE LYCHEE STINK BUG, TESSARATOMA PAPILLOSA. Wen-kui Chen, Shin-fon Chiu (Laboratory of Insect Toxicology,South China Agricultural University, Guangzhou 510642, China)

In South China the Lychee stink bug, Tessaratoma papillosa Drury is a very serious pest of the Lychee and Longan tree. It passes only one generation each year. It was found that there is a great variation in the insecticide tolerance (natural resistance) of the adults to trichlorfon in the spring and winter.

The activity of mixed-function oxidases (MFO) was examined in the midgut and the fat bodies of the Lychee stink bug during different seasons by method of expoxidation of aldrin. Results showed that the activity of MFO was the lowest during the overwintering period, being 1.66×10^{-3} μmol/min. and the highest during the reproductive period, being 3.33×10^{-3} μmol/min. No significant relation between the tolerance to trichlorfon and the activity of MFO during different seasons was found. The tolerance of the Lychee stink bug to trichlofon and the resistance of insect to insecticides is discussed.

#13

GOSSYPOL AS CHEMOSTERILANT TO COTTON BOLL WORMS. Yun-xi Liu, Gui-lin Cheng (Horticultural Research Institute of Qingdao, Qingdao 266071, China)

Gossypol, a chemosterilant for men, was confirmed to act sterility for male cotton boll worms after laboratory and field experiments during 1984-1989. The male moths on the second day after emergence fed with gossypol in sugar solution for 24 hours became sterilized. Allowing the sterilized male moths to fly in fields, the females did not lay eggs or significantly reduce the quantity of eggs, and the eggs couldn't be hatched, thus obviously decreased the pest population in the field. However, field spraying with gossypol solution did not kill or sterilize the pest at any age.

Experiments carried out according to IPM and SMR principles in the fields of 266 ha showed that using gossypol as a chemosterilant to male cotton boll worm was effective thus opened up a way to comprehensive usage of cotton by products, reducing amounts of pesticides used, increasing effectiveness of pest control and diminishing public pollution.

#14

MULTIPLICATIVE EFFECT OF INSECTICIDE FOR CONTROLLING APHIDES BY PLANT EXTRACTIONS. Qin Tang, Shicui Chang (Scenic Spot Management office of Nanshan Montain, Chongqing 630065, China)

Extracts of eight cultural and wild plants, including *Pinus massoniana*, *Eucalyplus robusta*, *Cinnamomum camphora*, *Platycladus orientalis*, *Michelia alba*, *Citrus grandis*, *Zanthoxylum simulaus* and *Artemesia argyi*, were respectively mixed with three organophosphorus insecticides (Ploxim Omethoate and Dichlorvos) for controlling the aphides on some oranamental plants. The results show obvious increasing effect in some trail combines.

1. Ploxim 3 ppm was blent with as mentioned above eight plant extracts at 120 times respectively, average multiplicative effects (AME) are from 22.95% to 48.47%. AME of *M. alba* leave extraction is more distinct. Ploxim was mixed with leave extracts of *Z. simulausy*, *F. robusta*, *C. grandis* at 240 times respectively. Mixtural toxicity Lc50 could were increased 1—2 times (evaluating by the same percentage of mortality). Mixed with plant extraction, dose of insecticide was decreased respesctively 65.80%.. 58.80% and 40.67% compared with single using of Ploxim.

2. Omethoate was combinated with eight plant extracts at 120 times as mentioned above, many composites indected certainly magnify effect, for xample *Mentha heplocalyx* was better, AME is 25.42%, besides *P. orientalis*, *Z. simulas* and *A. argyi*.

3. Dichlorvos 6.4ppm was mixed with eight plant extracts at 120 times respectively for controlling *Astegopteryx bambusifiliae*, the results showed no obvios increasing effect.

4. The results of the field trail indecated that Ploxim byend with the other plant extracts at 250 times except *P. orientalis* obtaine obvious magnify effect for controlling *A. bambusifoliae* *Macrosiphoniella sanborni* and *Neophyllaphis podicerpi*.

#15

EFFECTS OF THREE SYNERGISTS ON PENETRACTION OF FENVALERATE TO LARVAE CUTICULAR OF COTTON BOLLWORM. Jian-guo Tan, Jin-liang Shen, Fu-jie Tan, Zi-ping You (Department of Plant Protection, Nanjing Agricultural University, Nanjing 210014, China)

The cuticular penetration dynamics of ^{14}C-fenvalerate to 6th instar larvae of cotton bollworm, Helioths armigera (Hubner), was investigated. At 1 hr after topical treatment, the cuticular penetration into larvae reachs the highest rate and the reduce rate of ^{14}C-fenvalerate on cuticular surface is 70.40%. At 2 hr, the relative content of fenvalerate is 16.25% in the coelom (including organs) and 14.85% in the cuticule which is the greatest value detected in the cuticule during the penetration dynamics. At 24 hr, the contents of fenvalerate decrease to 3.5% in cuticle and increase to 28.44% in coelom.

The cuticular penetration of fenvalerate to 6th instar larvae is obviously affected by three synergists(TPP, Pb and DEM) when these synergists are mixed with fenvalerate. Two penetration peaks appear at 1 hr and 10 hr respectively after topical treatment. At 1 hr, the reduce rate of fenvalerate on the cuticule surface is 10.09%(TPP), 19.29%(Pb) and 59.69%(DEM). At 24 hr, the relative amounts of fenvalerate in the coelom are 11.05%(TPP), 13.78%(Pb) and 20.93%(DEM), and the relative contents of fenvalerate in cuticule are not affected by synergists. It is, therefore, suggested that the effect of these synergists on the cuticular penetration of fenvalerate to cotton bollworm larvae belongs to the competitive impediment or inhibition effect which mainly appears in the beginning of penetration.

#16

STUDIES ON TOXICITY OF ESSENTIAL OILS TO STORED-GRAIN PESTS. Dejun Yang,Changpei Hua & Shilin Hu (Research Institute Of Daily-Use Chemical Industry Of Sichuan Province,Chongqing,, China,630065)

The toxic screening of 65 essential oils has shown that the fumigation effects of 30 kinds of the oils (Citrus reticulata Blanco oil,etc),at the dosage of 100 ppm (v/v),were 100 % within 48 hours against Tribolium confusum Duval. At 50 ppm (v/v),the fumigation effects of C.reticulata Blanco oil (distillation),Mentha spicta L. oil and Cinnamomum camphora L.oil from the 26 kinds of the oils,were 100,98 and 93.3 % respectively against Sitophilus zeamais Motschlsky. The result of the fmigation effects of 11 oils to 4 kinds of stored-grain pests indicated that the tolerant order of the tested insects was:S.zeamais Motschulsky > Oryzaephilus surinamenzsis L. > Callosbruchus chinesis L. > Cryptolestes schouherr.The toxic evaluation of C.reticulata Blanco oil, Eucalypts globulus Labill oil and Pinus massonina Lamb oil to S. zeamais Motschulsky and T. confusum Duval suggested that the toxic order (LC50) was: E. globulus Labill oil > C. reticulata Blanco oil > P.massoniana Lamb oil. Through the component analysis of C. reticulata Blanco oil, E. globulus Labill oil and P. massoniana Lamb oil by GC, TLC and TLC/IR, 11 main components were separated from the oils to compare their toxicity against S. zeamais Motschlsky and considered that 1,8-limonene & P-cymene to be the effective components for C.reticulata Blanco oil;eucalyptol & B-pinene for E.globulus Labill oil;a-pinene & B-pinene for P.massoniana Lamb oil. This study has important value for the research and development of essential oils in the application of controlling stored-product insect pests.

#17

STUDIES ON THE ANTIBACTERIAL SUBSTANCES OF PIERIS RAPAE INDUCED BY DELTAMETHRIN and TRICHLORFON. Peng-fei Zhu (Laboratory of Insect Toxicology, South China Agricultural University, Guangzhou 510642, China) and Zi-qiang Lu (Department of Plant Protection, Jiangsu Agricultural College, Yangzhou 225001, China)

Antibacterial substance can be induced in the haemolymph of the 5th instar larvae of Pieris rapae by the topical application of deltamethrin and trichlorfon. Antibacterial substance first appeared in 1.5, 3.5 and 9.5hrs after treatment by LD_{50}, LD_5 deltamethrin and LD_5 trichlorfon respectively and could last for about 5 days. The peak of the immunological reaction was in the period of 2 to 3 days after treatment. The active antibacterial polypeptides were found in the 3rd day after the application of the insecticides. The physiological and toxicological importance of the immunological reaction was discussed.

#18

THE DIFFERENCES IN CONTRIBUTION OF *KDR* FACTOR ON THE THIRD CHROMOSOME TO THE RESISTANCE OF SOME PYRETHROIDS IN HOUSEFLIES. Takada, Y.; Kawada, H.; Hirano, M. (Agricultural Science Research Laboratory, Takarazuka Research Center, Sumitomo Chemical Co.,Ltd., Takarazuka, Hyogo *665*, Japan)

We investigated the contribution of *kdr* factor on the third chromosome to the resistance of some pyrethroids in permethrin selected Akagi PP15 strain of houseflies.

The resistance to the pyrethroids with 3-phenoxy benzyl alcohol moiety was much associated with *kdr* factor. On the other hand, the contribution of *kdr* factor to the pyrethroids with aliphatic alcohol moiety was much less than that of the pyrethroids described above. Furthermore, the contribution of *kdr* factor to the pyrethroids with cyclopentenolone or hydantoin alcohol was intermediate between those of both types of pyrethroids.

In contrast, the contribution of the *kdr* factor was not concerned with acid moiety of pyrethroids tested. Therefore, the differences in contribution of *kdr* factor on the third chromosome to the pyrethroids are thought to be dependent on the alcohol moiety of them.

#19
AMPLIFIED CARBOXYLESTERASE-B GENE RESPONSIBLE FOR INSECTICIDE RESISTANCE IN Culex pipience molestus

Tomita, T.[1], Kono, Y.[1] and Shimada, T.[2] ([1]Dept. Med. Entomol., Natl. Inst. Health; [2]Facl. Agri., Tokyo Univ.)

Organophosphorus insecticide resistance in the Shinjuku strain of C. p. molestus is associated with an increased detoxifying activity of carboxylesterase-B (CE-B, MW62,000), resulting from amplification of the corresponding structural gene. The Shinjuku strain, which has been maintained with no insecticide selective pressure for 60 generations since laboratory colonization, was compared to the insecticide susceptible strain, Totsuka, with the following results: (i)CE-B gene (or its homologous sequence) was amplified at least 500-fold. (ii)CE-B protein and naphtylacetate hydrolase activity increased 12 and 30 times, respectively. (iii)The ratio of fenitrothion resistance was 50, and this value was 3 times lower than that in generations just after colonization.

We also present the results of chromosomal in situ hybridization and structural analysis of amplyfied sequences.

#20
RELATIONSHIP BETWEEN PYRETHROID-ENHANCED BATRACHOTOXIN BINDING AND PYRETHROID TOXICITY TO SUSCEPTIBLE AND RESISTANT TOBACCO BUDWORM MOTHS. Cole J. Church, Charles O. Knowles (Department of Entomology, University of Missouri, Columbia, MO 65211, U.S.A.)

Some pyrethroids and DDT stimulated the binding of [^{3}H]batrachotoxinin A 20-α-benzoate (BTX-B) to neural membranes of tobacco budworm, Heliothis virescens (F.), moths from a pyrethroid susceptible strain and from a pyrethroid resistant strain (PEG 87) with multiple resistance mechanisms including nerve insensitivity. Stimulation of [^{3}H]BTX-B binding by pyrethroids and DDT was generally greater with membranes from susceptible moths than those from resistant moths. However, these insecticides differed in their ability to enhance [^{3}H]BTX-B binding and in their toxicity to tobacco budworm moths, and the relationship between these two actions will be discussed.

#21
THE STUDY OF THE MECHANISMS OF PERMETHRIN RESISTANCE IN HOUSEFLIES USING [^{3}H]PERMETHRIN. Goriunova T., Chankina O., Alexeev A. (Institute of Chemical Kinetic & Combustion Acad. Sci. USSR, Institutskaja 3, Novosibirsk 630090, USSR).

Radiolabeled [^{3}H]permethrin (1.5 Ci/mmol, 98% purity was used to study insecticide distribution in housflies. The dynamics of the processes of penetration, metabolism and excretion of permethrin and its metabolites was studied in the susceptible (S) and laboratory selected on the basis ot its resistance to permethrin (R_{Pm}) strains (LD_{50} 2.0 μg/g and 22 μg/g respectively). Our methods allow one to analyse individual flies. A populational analysis of S and R_{Pm} strains with 1 and 16 hrs exposures was performed. It was shown that one of the mechamisms responsible for the formation of resistance is a substantial decrease of cuticle penetration for permethrin in the R_{Pm} straine.

#22
THE ELECTROPHYSIOLOGICAL MECHANISM OF RESISTANCE EVOLUTION BY INSECTICIDE MIXTURE IN HOUSEFLY (Musca domestica L.). X.F. Li (Beijing Agricultural University, Beijing 100094, China), P.A. Zhou (Peking University, Beijing 100871, China), Z.Z. Shang (Nankai University, Tianjin)

Former study showed that housefly had developed higher resistance level by selecting of deltamethrin (F_{76}, 471 fold) or phoxim (F_{38}, 1687 fold), while mixture is low (F_{67}, 8-fold). In vivo measurements of dorsal longitudinal flight muscle (DLM5) identify that deltamethrin strain is longer than M strain, the shortest is phoxim strain in the time of repetitive discharge appearence and discharge disappearence after deltamethrin was used. Nervous system of deltamethrin strain was far less sensitive than phoxim strain. The strain selected by mixture showed decreasing of nerve sensitivity slightly. The resistance development may be suppressed when insecticides (deltamethrin and phoxim) are used as a mixture and the "anti-resistance" will occur in housefly population.

#23
BIOCHEMICAL MECHANISM OF MULTI-RESISTANCE CABBAGEWORM (Pierise rapae L.). X.F. Li, X.L. Han, W.J. Zhang (Beijing Agricultural University, Beijing 100094, China)

Bioassays showed that the cabbageworms from Beijing developed resistance to several insecticides including trichlorfon, dichlorphos and pymethroids. Using photometric methods, the highest MFO-demethylation activity was found in guts homogenates of last instar cabbageworm larvae and the highest AchE activity in head homogenates. The in vitro biochemical study identify that high MFO-demethylation activity, high esterase activity and high AchE activity are related to the development of cabbageworm's resistance. Insensitive acetylcholinesterase and competition mechanism of carboxylesterase played an important role in the biochemical mechanism of Multi-resistance cabbageworm.

#24
COMPARATIVE EVALUATION OF BIOASSAY METHODS AND DEVELOPMENT OF INSECTICIDE RESISTANCE IN FIELD POPULATIONS OF PLUTELLA XYLOSTELLA(LEPIDOPTERA : PLUTELLIDAE). S. C. Lee, Y.S.Cho and D.I.Kim (College of Agriculture, Chonnam National University, Kwangju, S. Korea)

Four bioassay methods for detection of insecticide resistance in diamondback moth, *Plutella xylostella* L., were evaluated. The topical application technique (CV = 8.0%) showing contact effect was the least variable among the 4 methods, but required time consuming and cost. The leaf disc method(CV = 11.4%) for stomach effect was less variable than leaf disc-insect dipping method (CV = 14.9%) for contact-stomach effect and insect direct dipping method(CV = 17.4%) for contact effect. Thus, the method of choice could depend on the purpose of tests, labor cost to treat them, and equipment costs, etc. In a comparison of the resistant field populations with a susceptible population, at LC_{50} values, populations collected from the Kwangju, Kimhae, Jaeju, and Injae cabbage fields in Korea were 141.7, 37.5, 32.5, and 7.5 times, respectively, as resistant as the susceptible to cypermethrin. Cartap resistant levels of the Kwangju, Kimhae, Jaeju, and Injae populations were 33.3, 12.3, 12.3, and 10.5 times, respectively. The Kwangju, Kimhae, Jaeju, and Injae populations showed 61.1-, 5.6-, 5.4-, and 3.3-fold resistance, respectively, to prothiofos. Trimuron resistant levels of the Kwangju, Jaeju, Injae, and Kimhae populations were 244.4-, 114.8-, 92.6-, and 32.6-fold, respectively. This is the first report on development of insecticide resistance in Korean diamondback moth populations.

#25

STUDIES ON RESISTANCE OF ALLISSONOTUM IMPRESSICOLLE ARROW IN SUGARCANE TO INSECTICIDES. Heng-liang Gong, Jin-yu Li (Division of Plant Protection, Sugarcane Industry Research Institute, Ministry of Light Industry, Guangzhou, 510316, China)

The resistance of the important underground pest A. impressicolle in sugarcane to six insecticides has been studied by topical application in laboratory. The results showed that the resistance of 3rd instar larvae in R-strains to isofenphos-methyl, phoxim, monocrotophos, carbonfuran, fenvalerate and gamma-BHC was 10.1-, 10.0-, 6.6-, 6.9-, 24.3-and 14.2-folds, respectively, as compared with the LD50 value of S-strain. The resistance management of A. impressicolle in sugarcane was also discussed.

#26

INSECTICIDE RESISTANCE STUDY IN DIAMONDBACK MOTH(PLUTELLA XYLOSTELLA). Li Xie, Yong Zeng, Kuan-yan Seng, Tong-xu Peng (Guangdong Entomological Institute, Guangzhou 510260, China)

A general survey of resistance in diamondback moth, Plutella xylostella L., to cartap, fenvalerate and acephate in Guangdong was conducted using third instar larvae by a Potter Spray Tower. Four field populations were collected from south to north in the province including Shenzhen (S1, S2), Guangzhou (G), Yangshan(Y).The resistant levels of the four populations were determined to compare with two susceptible strains(from Hubei and Taiwan) in which the resistant levels were very low and similar. Compared with Hubei strain, resistant ratios (R/S) of S1 (the strain collected from Shenzhen and reared 57 generation in the laboratary) were 2.5 for cartap, 3.7 for fenvalerate, 4.5 for acephate, and the ratios of S2 were more than 11 for cartap, more than 13 for fenvalerate, and the ratios of G were 3.5 for cartap, 4 for fenvalerate, 3.2 for acephate, and ratios of Y were 6.3 for cartap, 1.3 for fenvalerate, 6.5 for acephate. The activities and isoenzymes of esterase, acetylcholinesterase, acid phosphatase and alkaline phosphatase were analysed for susceptible and resistant strains.

#27

MORNITORING TECHNIQUE FOR INSECTICIDE RESISTANCE OF DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA* L. Jian-zhou Zhao (Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, Beijing 100081, China) & Edward J. Grafius (Department of Entomology, Michigan State University, East Lansing, MI 48824, USA)

Monitoring technique of insecticide resistance of the diamondback moth (DBM), *Plutella xylostella* L. was studied in Michigan, USA. The objective of this research was to develop a on-farm monitoring technique which could be used both to detect the resistance at low level and for the choice of insecticides for DBM control. The resistance ratios (RRs) of DBM to permethrin and methomyl were 26.9 and 4.1, respectively, compared with a susceptible DBM strain from Geneva, NY at the beginning of this research. Significant difference of control by permethrin and no difference by methomyl were found between the larvae of resistant and susceptible DBM strain under field conditions. It was proved that both the LC90 of the susceptible DBM strain and the recommended field concentrations could be used as discriminating concentrations for resistance monitoring to permethrin and methomyl. Leaf disk dip method was recommended which was effective for detecting the resistance to both insecticide in 8 or 24 hours after treatment. The validation with field DBM larvae was needed before actual on-farm application.

#28

STUDY ON RESISTANT MECHANISM AND FORMATION OF DIAMOND MOTH TO DIMEHYPO AND CARTAP. Chen Zhihao, Liu Chuanxin, Li Fengtiang and Han Zhaojin (Institute of Ptant Protection, Guizhou Academy of Agri. Sci. Guiyang, 550006)

4 instars larvae of Diamond moth were treated with Dimehypo and cartap by topical application method in the lab. for screening and increasing resistance of Diamond moth. Up to 35th generation, the resistances of Diamond moth to dimehypo and cartap were increased 51 and 25 times respectively than untreated normal strains. The development of resistance of Diamond moth vs time appeared to be "s" shape.

The sensitivities of dimehypo-resistance and cartap resistance strains to 11 type of insecticides were tested, the result showed that the resistant strains had remarkable positive cross-resistance to dimehypo, cartap and thiocydam, and slight positive cross resistance to DDVP malathion and fenitrothion, negative cross-resistance to deltamethrin, cypermethrin, permethrin, methomyl and thiofanox. The results obtained from PAGE showed that the resistance to insecticides were related to the special type of Esterase. The activities of CarE and AchE of resistant strains were determined by colorimetric and acidity analysis respectively. The results indicated that the AchE activity was decreased, but the CarE had no difference, addition of synergist (Pb or Syl) to the 4 instars larvae, the synergism of dimehypo resistance strains were determined to be 6.28 and 1.45 times, the cartap resistance strains were 4.85 and 1.39 times respectively. So it seems to be that MFO is an important factor for Diamond moth to resist dimehypo and cartap.

#29

STUDIES ON RESURGENCE OF CITRUS RED MITE, PANONYCHUS CITRI MCGREGOR, AND ITS CONTROL. Xing-xiang Ye, Qiang Wang, Qi-min Ye (Institute of Plant Protection, Zhejiang Academy of Agricultural Sciences, Hangzhou 310021, China), Dao-mao Chen, Wei-min Chen (Citrus Institute, Zhejiang Academy of Sciences, China), Chun-zhou Zhang, Li-fen Jin (Wenzhou Institute of Agricultural Sciences, Zhejiang, China), Ben-chang Li, Shi-xiong Wu (Institute for Control of Agrochemical, Ministry of Agriculture, China)

Numerous application of pesticides has resulted in the resurgence of citrus red mite (CRM), Panonychus citri McGregor and caused it to become the most important insect pest in citrus. It show that Dicofol, Omethoate, Optunal and Fenvalerate often used for pest control are fatal to various enemies of CRM, such as predatory mites, ladybugs, thrips, spiders and parasites. Pyrethrins, such as Fenvalerate and Deltamethrin, have positive effects on prolonging the life-span of female adults, increasing numbers of egg, and increasing the hatching rate and hatching speed of egg. And CRM has been resistant to Omethoate and Optunal. These are the three factors of resurgence of CRM. In order to control CRM, several new miticides, such as Hexythiazox, Fenbutatin Oxide and Azocyclotin, are selected out. Measures for controlling CRM using new miticides are also proposed. In the regions where these miticides and measures are applicated, CRM and well controlled, numbers of enemies increase and residues in citrus fruits decrease.

#30

INVESTIGATION ON RESISTANCE TO FENVALERATE BY COTTON APHID, APHIS GOSSYPII. Kong-ming Wu, Qin-xuan Liu (Institute of Plant Protection, Henan Agricultural Academy of Sciences, Zhengzhou 450002, China)

The resistance level of cotton aphid to fenvalerate, omethoate and monocrotophos in Henan cotton area was detected during 1988-1990 and the result showed a rapid growth to this three pesticides, especially fenvalerate. The susceptible cotton aphid was selected eight times by fenvalerate in laboratory, which resulted in resistance being as high as 1400-folds, cross resistance of 2-4 folds to monocrotophos and omethoate was also followed. The life table analysis to four different resistant strains indicated a positive relationship between fenvalerate resistance and intrinsic rate of natural increase.

The bioassays of eight insecticides respectively belonged to pyrethroid, organophosphate and amidine, and their mixtures to high resistant cotton aphid presented that DDVP had a high toxicity and the mixtures of amidine and pyrethroid could get a significant synergism, but antogonism was found for the mixtures of DDVP and others.

#31

INVESTIGATION ON THE RESURGENCE CAUSED BY INSECTICIDES FOR COTTON APHID, APHIS GOSSYPII. Kong-ming Wu, Qin-xuan Liu (Institute of Plant Protection, Henan Agricultural Academy of Sciences, Zhengzhou 450002, China)

Fenvalerate, omethoate and monocrotophos are the major pesticides for the chemical control of cotton aphid in Henan Province. The result of simulating application in cotton field showed that plots treated successively three times with fenvalerate or four times with omethoate would induce the aphid population outbreak. The detection of the aphid resistance indicated that as the number of insecticide using increased, the resistant level rose quickly, the fouth later, fenvalerate LD_{50} was 9.4-folds compared to that before chemical control. Laboratory study found that pesticides were remarkably high toxic to natural enemy such as Cocenella septempunctata and Leis axyridis. The analysis of life table for adult and nymph aphid treated respectively by three pesticides pointed out that the r_m value and other life indexes were not obviously different with untreated aphid.

According to the experimental result above, it is suggested that fenvalerate and omethoate successively applying to control cotton aphid be unsuitable. The main reasons of resurgence-inducing are mountly killing natural enemy, destroying ecosystem of cotton field and making fast increase of aphid resistance.

#32

SUSCEPTIBILITY OF TWO RICE PLANTHOPPERS TO 10 INSECTICIDES. Tianxi Liang, Lixin Mao (China National Rice Research Institute, Hangzhou 310006, China)

FAO/IRRI standard topical application method was used for monitoring susceptibility levels of *Sogatella furcifera* Horváth (WBPH) and *Nilaparvata lugens* Stål (BPH) to 10 insecticides (organophosphorus, organonitrate and pyrethrin) during 1987-1990. The monitoring results indicated:

1. According to the toxicity order (LD_{50}) of insecticides, both hoppers were the most susceptible to carbofuran and the least to malathion. A wide variation of susceptibility of the two rice hoppers to different organophosphorus insecticide varieties were existed, monocrotophos and diazinon were much toxic.

2. The development of resistance to insecticide in WBPH population was faster than that of BPH. As compared with LD_{50} values reported by Nagata (1967, Japan), WBPH has a 110.56-fold resistance to malathion, 48.90-fold to fenitrothion and 11.61-fold, 6.11-fold for BPH, respectively.

3. The LD_{50} values fluctuated among years as both hoppers population were migrant insects. There was a negative relation between resistance level of BPH and local chemical used.

#33

INSECTICIDE RESISTANCE MANAGEMENT PROGRAM FOR BEMISIA TABACI AND HELIOTHIS ARMIGERA IN ISRAELI COTTON FIELDS. A. Rami Horowitz, I. Ishaaya (Department of Entomology, The Volcani Center, ARO, Bet Dagan 50250, Israel), G. Forer (Israeli Cotton Board, Tel- Aviv 67132, Israel).

In 1987, an insecticide resistance management (IRM) strategy for Bemisia tabaci and Heliothis armigera was introduced in the Israeli cotton system. The main goals were to restrict the use of pyrethroids and endosulfan to a short period during the cotton season, to delay the onset of resistance and to preserve beneficial agents during the period when treatments are not applied (May-July). Another important purpose of the strategy was to prolong the life span of new insecticides by optimizing their use through monitoring field pest tolerance.

Since the implementation of the program in 1987, we observed a definite relaxation in resistance development in H. armigera and B. tabaci for various OPs, endosulfan and pyrethroids. Assays done during the cotton seasons of 1989-1991, showed no significant differences in B. tabaci susceptibility to the novel IGRs, buprofezin and pyriproxyfen; these findings apparently resulted from restriction of the IGRs use to 1 month during the cotton growing season, in accordance with the IRM strategy.

#34

MIXTURES OF PYRETHROID PLUS ORGANOPHOSPHORUS COMPOUND AS A MEASURE AGAINST RESISTANCE DEVELOPMENT OF INSECT TO INSECTICIDE

Zhang Wen-ji and Han Xi-lai, Chen Nian-chun, Luo Ji-tai (Beijing Agricultural University Beijing 100094, China)

A study on development of house fly, *musca domestica L.* to single pyrethriod alone and mixture of deltamethrin or fenvalerate plus phoxim by continuous selection method was conducted in laboratory. All mixtures can markedly lower the level of resistance than pyrethriod alone and notable change in sensitivity by the application of the mixture was observed even after the selection 18 generations. The suppressive effect is due to reduction of selection of pressure each insecticide in the combination on respective generations and synergistic action between deltamethrin and phoxim in the mixture. All strains of house fly selected by mixture display almost no resistance to the initial single insecticide, deltamethrin or phoxim. Successive selection of peach aphid, *myjus persicae S.* by mixture of fenvalerate and phoxim proved also that the selected strain has no ability to easily develop its resistance to mixture.

#35

RESISTANCE OF CITRUS RED MITE, PANONYCHUS CITRI MCGREGOR (ACARINA: TETRANICHIDAE) TO PESTICIDES AND JOINT ACTION OF PESTICIDES. Qiang Wang, Xing-xiang Ye, Qi-min Ye (Institute of Plant Protection, Zhejiang Academy of Agricultural Sciences, Hangzhou 310021, China)

Resistance of citrus red mite (CRM) Panonychus citri to organophosphates, organochlorines and a new miticide (Hexythiazox) was detected and monitored or the basis of the toxicity of several groups of insecticides/miticides. Results showed that pyrethroids, ketone compounds and organochlorines (more than 159 of relative toxicity index, TI) were more toxic to CRM than organic tin and sulphur compounds, organophosphates and inorganic pesticides (less than 72 of TI). CRM in main regions of citrus plantation of Zhejiang and Changxing Island of Shanghai has been resistant to Omethoate and Optunal (5.0-14.0 and 6.0-31.9 times of R/S, respectively), but no resistance of CRM to Dicofol found out. It was showed in the simulationg test that the susceptibility of CRM treated successively by Hexythiazox for 4 times will decrease to some extent. It seemed that resistance of CRM in Hangpu of Ju County to Hexythiazox has existed (6.1 times of R/S), but CRM in Shanyi of Xiaoshan County was still susceptible (1.5 times of R/S). Several mixtures of Omethoate, Dicofol, Hexythiazox and other insecticides/miticides showed synergistic to CRM (12.6-58.7% of synergistic effect and 143-256 of co-toxicological coefficient).

#36

THE CHARACTERISTICS AND THE EFFICACY OF CHLORFLUAZURON AND THE BPU'S RESISTANCE IN *Plutella xylostella*

Kiyomitsu Yoshida, C. Tatsumi and T. Toki (Agrochemicals Development Laboratory, Ishihara Sangyo Kaisha, LTD., Kusatsu, Shiga, Japan)

Chlorfluazuron is one of the promising BPU type IGRs which have been developing and commercializing all over the world. There has been a lot of papers concerning these insecticides.

Chlorfluazuron showed the characteristic efficacies on the lepidopterous insect pests. 1) The higher susceptibility against chlorfluazuran was observed at a higher temperature on *P. xylostella*. 2) Applying chlorfluazuron to the larvae of *P. xylostella* at the early time of each instar period, both the 1st and the 2nd instar larvae died at the 2nd moulting time, the 3rd and the 4th instar larvae died at the 3rd and the 4th moulting (pupating) time respectively. 3) Chlorfluazuron was more effective to the larvae just before the apolysis than to those just after the moulting on the 5th instar larvae of *Spodoptera litura*.

On the other hand, we investigated the resistance of *P. xylostella* against IGRs. This problem is becoming a serious problem in some regions in South-East Asia. The results were as follows: 1) The synergistic activities of piperonyl butoxide greatly depend on the period of application. 2) By mixing with other insecticides, chlorfluazuron showed a small synergizing effect. 3) The susceptibilities against chlorfluazuron were investigated on *P. xylostella* from three regions (Mizobe, Atsumi and Tsumagoi) in Japan. Only one strain from Mizobe was less sensitive than the susceptible strain.

#37

POPULATIONAL ANALYISIS OF THE SUSCEPTIBLE (S) AND RESISTANCE TO PERMETHRIN (R) HOUSEFLIES STRAINS USING [^{3}H]PERMETHRIN. Alexeev A., Goriunova T., Chankina O. (Institute of Chemical Kinetic & Combustion Acad. Sci. USSR, Institutskaja 3, Novosibirsk 630090, USSR)

The method involving a highly active [^{3}H]permethrine (1.5 Ci/mmol, 98% purity) was developed to study the processes of the penetration, metabolism and excretion of the permethrin and its metabolites in individual flies. A populational analysis of the S and R strains was performed. It was shown that the cuticle penetration for permethrine and the ratio between excreted and penetrated quantities of tritium (excretion coefficient) can serve the criteria for the determination of resistant individuals in population. The population analysis of successive generations (1, 3 and 5) of the R strain after removal of insecticide press testifies that the decrease in permethrine resistance is caused by the changes in population structure.

#38

RESISTANCE IN MYZUS PERSICAE TO ORGANOPHOSPHORUS AND CARBAMATE INSECTICIDES. Xi-wu Gao, Bing-zong Zheng, Ben-jun Cao(Department of Plant Protection, Beijing Agricultural University, Beijing)

Since 1986, a five-year systematic monitoring of insecticide resistance in Myzus persicae (Sulzer) had been conducted in Beijing suburbs and Langfang region in Hebei Province. Results showed that the highest resistant factors, based on the LD_{50} (ug/aphid) by means of topical application, were 230-fold to dimethoate, 185-fold to omethoate and 245-fold to pirimicarb, but susceptible to carbaryl(only 1.2-fold), as compared with the susceptible colony at Langfang. The toxicities of dimethoate and omethoate to the aphids in Beijing suburbs were enhanced by the synergist piperonyl butoxide(Pb) or TPP, the synergic factors of Pb were 7.1 and 6.0 and the factors of TPP were 3.2 and 12.1, respectively. It suggested that carboxylesterase and mixed function oxidase were likely to be involved in the resistance of the aphid to above insecticides. The resistant levels of Myzus persicae to dimethoate, omethoate, malaoxon and pirimicarb were fairly correlated with the frequencies of the individuals with carboxylesterase activities more than 0.5 OD_{555} (B-naphthyl acetate as substrate) value/1 aphid, 15 min. The sensitivity of AChE in the resistant Myzus persicae colony to omethoate and pirimicarb was lower than the susceptible colony collected from Langfang region in Hebei Province, and this was correlated with the degree of resistance in the aphids to omethoate, dimethoate and pirimicarb. It suggested that altered AChE were likely to be one of the resistant mechanism in Myzus persicae to organophosphorus and carbamate insecticites.

#39

PESTICIDE AND PESTICIDES MIXTURE RESISTANCE IN COTTON BOLLWORM, HELIOTHIS ARMIGERA AND RESISTANCE MECHANISM. Cen Wei, Xian-lin Fan Yong-qiao Zhao. Chang-hui Rui, Xiao-ping Sun Wen-lai Wang (Institute of Piant Protection, CAAS, Beijing 100094, China)

The cotton bollworm were collected from Baoding City, Hebei Province and reared separately in four populations in the laboratory. After 16 times of separately succussive selection, the resistance of the population treated with fenvalerate increased 68.02-fold, the resistance of the population treated with malathion increased 7.76-fold, and the resistance of the population treated with the juma concentrate emulsion increased only 3.48-fold and still belonged to the susceptible strain (over 5-fold belongs to the resistant strain). It showed that the mixed formulation has the delayed action to the cotton bollworm resistance. The determination of the enzyme activity in vitro showed that the carboxylase activity in the population treated with fenvalerate was three times higher than that of the population treated with juma mixed formulation. The difference of Cholinesterase activity was 1.3-fold. The difference of glutathione-S-transferase activity was 1.5-fold. The difference of phosphatase activity was 1.2-fold. It proved that the increase of the esterase activity is one of the main mechanism to produce the resistance. The determination of the rate of penetration through the body wall of the larvae in different populations with ^{14}C-fenvalerate showed that the rate of penetration through the body wall of the selected population treated with fenvalerate decrease about 50% than that with juma concentrate emulsion. The lower penetration of pesticide through larvae body wall is another explaination of the resistance mechanism.

#40

PESTICIDES RESISTANCE IN MELON APHID APHIS GOSSYPII GLOV IN SHANG HAI REGION AND THE STRATEGY OF PEST MANAGEMENT. Shi-chang Wu, Hui-zhong Zheng, Zhong-liang Shen, Yunzhen Gu (Plant Protection Research Institute, Shanghai Academy of Agricultural Sciences) Shi-xiong Wu (Pesticide Inspect Institute, The Ministry of Agriculture, China)

The toxicity of twelve pyrethroids, two carbamate, seven organophosphate and four insecticide mixtures to melon aphid in the four counties of Jiading, Baoshan, Shanghai, Chuanshan in Shanghai suburbs has been determined from 1988 to 1991 in comparison with the toxicity(LC_{50}) of relatively sensitive stains in the initial stage. resistance of pyrethroids was increased in 70 to 720 fold. It showed high resistance and cross-resistance. The toxicity of pirimicarb was comparatively lower. The value of LC_{50} was 316.6 ppm in 1980 and 891.7 ppm in 1991. Dimethoate, malathon, acephate were within middle or high resistance. Phosalone was within lower to middle resistance. Dichlorovos, quinalphose, lannate and pesticide mixtures, as polytrin, fenvalerate+malathion, fenvalerate+fenitrothion, fenvalerate+dimethoate were all susceptible. The value of LC_{50} was 38.3-81.2 ppm. The TPP or SV_1 showed synergic effect to Fenvalerte in 12 and 3.7 times, respectively. The strategy of management is as follows:
1. Application of pyrethroids that have produced high resistance is not recommended. 2. Pesticides such as dimethoate, acephate that have produced certain resistance, can be used restrictively. 3. Alternate application of certain kinds of organophosphorous and carbomate pesticides like dichlorovos, quinalphos, lannate is recommented. 4. Reasonable application of polytrin, fenvalerate+malathion, fenvalerate+dimethoate that have proved to be effective is recommended. 5. Timing and dosage of using pesticides must be under guidance.

#41

THE RESURGENCE OF COTTON APHIDS AND LEAF MITES INDUCED BY FENVALERATE. Han Lijuon, Ku Zhongyan, Wang Qiang, Huong Xionglin, Xu Xiaolong(Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences, Nanjing, 210014, China)

The population of Aphids(Aphis gossypiella Glover) or leaf mites (Tetranychus cinnabarinus Koch) on cotton leaves may develop quickly when only one dominant species is presented. The development of population may retard when both species are existing in balance on the same niche. Fenvalerate is considered as an effective aphicide when it was first to use but fail to control the mite properly. As the aphids were diminished on the cotton leaves after applying fenvalerate the mite will built up its population within 5 days and reach to 275 per plant at 23 days. when aphids and mites are presented on the same leaf in balance the mite will develop its population after 19 days and reach to 155 per plant at 30 days. Due to the development of resistant strain of aphids to pyrethroids the condition may reversed. After the application of fenvalerate a certain portion of mite were diminished but left a great portion of aphids on the leaves. Due to destruction of the balance of aphids and mites relation the resurgence of aphids or mites outbreak became evidently.

#42

HISTOPATHOLOGIC CHANGES OF EGG AND LARVA OF *PIERIS RAPAE* TREATED WITH DIMILIN NO.3. Feng-kui Wang, Jing-ze Zhang, Qiao-ying Zhang (Depart. of Plant Protection, Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

25% colloid suspension of Dimilin No.3, a insect growth inhibitor, was used to treat eggs and larvae of *Pieris rapae* L. to study their histopathologic symptoms. The inhibitor at test concentrations of 0.25–250 ppm had high toxicity to the embryo and the 1st–5th instar larvae. Histopathologic examination of paraffin and Epon 812 sections of treated eggs indicated that the inhibitor might impede the division of zygote, check the formation of doughter nuclei and germ band, cause a decrease in the quantity of yolk, weaken the structure of chorion, disrupt the amnion and serosa or give rise to partial absence of them, disintegrate the germ layers or the embryo itself, break the body wall and the endocuticle already formed, and shatter the rudiments of organs or organs. Also, the endocuticles of the poisoned larvae were thin, stripped and broken, and the fat–bodies became smashed, collapsed and even disappeared. The symptoms indicated that the metabolism of DNA, protein and cutin in treated insect was disturbed.

#43

EFFECTS OF ATABRON ON PHENOLOXIDASE AND CHITINASE OF OSTRINIA FURNACALIS LARVAL CUTICLE. Wu Gang (Department of Plant Protection, Fujian Agricultural College, Fuzhou), Shang Zhizheng (Institute of Elemeto-organic Chemistry, Nankai University, Tianjin)

The poisoned symptom of *Ostrinia furnacalis* treated by ATABRON was similar to that by TH6040 (diflubenzuron). ATABRON and TH6040, both in vivo and in vitro, all could inerease extensively the aetivity of phenoloxixidase and chitinase in larvae eutiele, and the stimulation of ATABRON was much more than that of TH6040. Compared with the control, when the larvae feed on ATABRON and TH6040 respeetively, the aetivities of eutieular phenoloxidase of fifth instar larvae was inereased respeetively by 276.00% and 28.00%, and the aetivities of chitinase was inereased by 70.91% and 10.91%. When ATABRON and TH6040 were respeetively injeeted into the abdomen of fifth instar larvae, the aetivities of phenoloxidase of its eutiele was inerease respeetively by 74.86% and 37.98%, and the aetivities of chitinase was inereased by 54.15% and 9.49% respeetively.

#44

EFFECTS OF BENZOYLPHENYLUREAS ON SEVERAL INSECT PESTS. Lei Shi, Shu-lian Lian (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Jilin Province 136100, China)

From 1984 to 1990, three benzoylphenylureas, diflubenzuron, benzoylphenylureas No. 3 (1-(4-chlorophenyl)-3-(2-chlorbenzoyl)urea) and trifluron were experimented systematically in Jilin Province, China. The laboratory experiments showed that ratio of LC50 stomach toxicity of diflubenzuron, benzoylphenylureas No. 3 and trifluron on the third instar larvae of Mythimna separata were 1:0.64:3.19. The field experiments and demonstrations showed that the mortalities of diflubenzuron at the rated of 22.5, 37.5 and 75.0(ai.)/ha. to 2-3 instar larvae of M. separata in wheat were 95.6, 94.4 and 96.9%, respectively, 7 days after treatments; the mortalities of benzoylphenylureas No. 3 at the rates of 120, 150 and 300g (ai.)/ha. were 97.4, 93.3 and 99.4%, respectively,9 days after treatments; the mortalities of trifluron at the rates fo 30.0, 75.0 and 150.0g(ai.)/ha. were 88.0, 89.8 and 85.8%, respectively, 4 days after treatments. Three chemicals were also more effective to Ostrinia furnacalis, Malacosoma neustria testacea, Hyponomeuta padellus, Pieris rapae, Mamestra brassicae and Plutella xylostella. The influence of three chemicals at the rates of recommended doses on natural emenies were negligible, such as Leis axyridis, Propylaca japonica and some mites, but caused significant mortality to Chrysopa sinica. The residual effect in the field reached 20 days, and was longer than organic phosphorus. The effects of three chemicals were not influenced by the rainfall. Three chemicals are safe to corn, soybean, rice, sorghum, millet, fruit trees and vegetables.

#45

EFFECT OF SEVEN FORMULATIONS OF IGR (INSECT GROWTH REGULATORS) AGAINST LEPIDOPTEROUS LARVAE ON CABBAGE. Ju-wen Wu, Su-qin Wang & Bao-de Wang (Institute of Plant & Environmental Protection, Beijing Academy of Agricultural & Forestry Sciences, Beijing 100081, China)

Results of the laboratory studies indicated that the killing effect of Mieyouniao No.3 and Dimilin (diflubenzuron) on one-day old eggs of *Pieris rapae* was greater than that of Cascade (flufenoxuron), NOMOLT (teflubenzuron) and XRD 473 (hexafluron). In the experiment of spraying Cascade, Atabron (chlorfluazuron, IKI 7899) and XRD 473, respectively, at the concentration of 50ppm on cabbage, the control effect against a mixed larval population of ***P. rapae, Plutella xylostella, Mamestra brassicae*** and ***Prodenia litura*** was over 90% 3 days after the application. By using the percentage of undamaged leaves of a cabbage plant in the treatment with Cascade as 100%, the relative percentage for other tested formulations were found to be in the order of Atabron (75.1%), XRD 473 (59.1%), Mieyouniao No.3 (43.7%) and NOMOLT (38.7%). To diminish development of resistance to these IGRs by the pests, it is suggested that only one application of IGR insecticides be used on each planting of cabbage in conjunction with judicious applications of other types of insecticides.

#46

RESISTANCE MONITORING OF PINK BOLLWORM MOTH (IEPIDOPTERA: GELECHIIDAE) WITH SEX PHEROMONE TRAPS. Wen-gu Li, Yi-ping Li, Chang-ben Huang (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China), Shou-shan Lou (Agriculture and Forest Bureau of Cixi city, Zhejiang Province, Zhejiang 315300, China), Zhong-xian Lu, Zhang-fa Yang (Institute of Plant Protection, Zhejiang Academy of Agricultural sciences, Zhejiang 310021, China)

Pheromone-baited sticky traps laced with a series of concentration of Fenvalerate, a pyrethroid insecticide, were proved to be a simple and effective means of monitoring insecticide resistance in the pink bollworm moth, *Pectinophra gossypiella* (Saunders). With this novel use of sex pheromone, adult males from cotton fields treated frequently with pyrethroid insecticide showed up to 26-28-fold resistance to Fenvalerate in Cixi, Zhejiang Province. It seems no difference between overwintering and second generation of male moth in the same population of pink bollworm to tolerate to Fenvalerate. This rapid and simple technique eliminated laborious handling of insects and should allow cotton growers to detect resistanceat early stage that is often considered essential to insecticide management.

#47

POTENTIAL OF A NEW JUVENOID W-328 IN INTEGRATED PEST MANAGEMENT. I. Hrdý, J. Kuldová, M. Říčánková, J. Wimmer (Institute of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, Praha, Czechoslovakia)

Ethyl 2-{4-/(1,4-dioxaspiro/4.5/dec-6-yl)methyl/ phenoxy}ethyl carbamate (W-328), a dicyclic derivative bearing a carbamate group in the side chain, is a potent development and reproduction regulator in aphids (Acyrthosiphon pisum, Myzus persicae, S- and R-biotype of Phorodon humuli) and an ovicide in tortricid and pyralid moths (Cydia molesta, C. pomonella, Lobesia botrana, Ostrinia nubilalis). Base line data from comparative bioassays of several juvenoids will be documented. Because of its low toxicity to mammals and water organisms W-328 is promising for further investigation. The results of field application of W-328 against the Oriental fruit moth, C. molesta on peaches will be shown as an example.

#48

Taxonomic status of a gall midge attacking terminal leaf buds of Salix viminalis.

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Plantations of Salix viminalis have recently been established in Sweden for biomass production. In 1988 extensive damage to terminal leaf buds and subsequent side shoot development was observed and the frequency of damage has continued to be high. The cause of the damage is a gall midge, Dasineura sp.n., closely resembling three other species, D. terminalis (H. Loew) producing galls on Salix alba and S. fragilis, D. iteobia (Kieffer) producing galls on S. caprea, and a species reared by Stelter as an inquiline from the galls of D. rosaria on S. repens and described by him under the name of Rabdophaga schreiteri. Morphometric studies revealed that the three first-mentioned of the above four species can be readily distinguished on the basis of the relative length of the ovipositor. So far, no clear structural difference has been found between D. sp.n. from S. viminalis, and the species from S. repens described by Stelter. However, the results of experiments dealing with the host plant relationships give evidence that these two midges are not conspecific. In oviposition preference trials, which included host plants of the four gall midges, D. sp.n. laid most of its eggs on S. viminalis. In performance trials, galls and pupae/adults of D. sp.n. did only develop on S. viminalis. The other three gall midge species laid no or very few eggs on S. viminalis, and no larvae survived.

#49

MICRCSCOPIC OBSERVATION OF IGR CYROMAZINE EFFECTS IN LARVAL Ceratitis capitata Wied. INTEGUMENT.Viñuela,E.:Budia,F.:Adan,A.; Jacas,J.;Del Estal,P.;Marco ,V.(Entomologia Agricola,E.T.S.I. Agrónomos,28040-Madrid)

Cuticular and epidermic effects of IGR cyromazine were observed in C.capitata larval integument. Microscopic examination of sections through affected areas revealed that much of the cuticle had ruptured and internal tissues were confined only by the epicuticle. Closer examination showed that much of the striated structure of the cuticle matrix had been lost, the helicoidal arrangement of the lamellae was disturbed and there were many cuticular inclusions and necrotic tissues.

The normal disposition of the epidermic layer under the cuticle was modified and the invasion of cuticle by epidermal cells was noticed. Also many epidermial cell alterations (microvilli, vacuole number, ceel shape) and electron-dense inclusions were observed.

#50

ANTIBODIES TO CARBAMATES. Yi-liang Zeng (Department of Pesticide Chemistry and Toxicology, Institute of Zoology, Academia Sinica, Beijing 100080 China)

Competitive Enzyme-Linked immunosorbent assays were developed for carbamate insecticides on residue analysis in the environment. By the condensed or combined reactions of naphthalene or bunzofuran derivatives with aminocaboxylic acids or succinic anhydride, a library of carboxylic derivatives structurally related to the insecticides Carbaryl and Carbofuran has been synthesized, for use as haptens, which were coupled to carrier proteins BSA, OVA, CONA and KLH for immunization of several rabbits to raise antibodies, for example, both NAPH5-KLHAb 1339 and NAPH6-KLHAb 2114. Some immunizing antigens were used as the coating antigens.

Antibodies resulting from the amide-acide derivatives have a specificity for carbaryl in the ELISA.The experments demonstrated that the antibodies NAPH6-KLHAb 2114-NAPH11BSA(2nd boosting, titer 1/6400) could quantitate carbaryl upon the linear range 5-400ng/ml, with a limit of detectability of 2.5ng/ml.

#51

THE SUSCEPTIBLE STAGE OF ANOPHELES BALABACENSIS TO A JUVENILE HORMONE ANALOGUE. Keiko Omata-Iwabuchi (Department of Immunology and Medical Zoology,St.Marianna University,School of Medicine,Kawasaki 216,Japan)

The most susceptible stage of An. balabacensis to 2-[1-methyl-2(4-phenoxyphenoxy)ethoxy]pyridine(S-31183) was examined. The last-instar larvae and pupae of An. balabacensis were immersed in S-31183 solution of 1ppb for 5 minutes, when they attained the stage appropriate for bioassay. The treatment with S-31183 did not affect the developmental period, but inhibited their adult emergence. However, the mortality was different among the treated stages. Release of ecdysteroids for pupal metamorphosis was followed by the increase of mortality. This is also supported by the investigation of ecdysteroid titer by the RIA method. Interestingly, when the ecdysteroid titer decreased just before pupation, also the mortality by treatment of S-31183 decreased. Therefore, this experiment indicates that a juvenile hormone analogue, S-31183 does not inhibit effectively the emergence of An. balabacensis because of deficiency of endogenous juvenile hormone.

#52

A STUDY ON ARTIFICIAL REARING OF TEA GEOMETRID AND PROPAGATION OF VIRUS (EoNPV). Jian-wen Hou (Nanjing College of Agriculture, Nanjing 210038, China)

Over the past half centry, tea geometrid (Ectropis obliqua Prout) has been one of the most important tea pests in the eastern China. As a result of chemical control, pestiside resistance and environmental pollution have increasingly developed.

A strain of EoNPV found by author in 1977 has been applied successfully in field experiment, artificial rearing methods and virus propagation have been studied during 1980's also.

An artificial rearing perseription used in 25 accumulative generations on tea geometrids are provided herein: tea powder 30g, soybean milk 10ml, vitamin C 0.5g, multivitamin-glucosan 5g, sorbic acid 0.3g, Nipagin 0.1g, agar 2.2g, water 100ml.

Massive propagation of EoNPV is recomended in this paper with some additional informations: (1) Most sensitive infection stage is in 4th instar. (2) The optimal concentration is 2X 100000 PIB/ml. (3) It takes 40 days for producing 14000 infected larvae with this method by a single person. Three workers can produce enough virus to control the pest of 10000mu in a year.

BIODEGRADATION OF ALDICARB AND ^{14}C-ALDICARB BY SOIL MICRO-ORGANISMS. J. X. Tang, Z. L. Li and T. T. Liang (Beijing Agricultural University, Beijing, 100094, China).

Pure culture of eight strains of bacteria and five strains of fungi had been isolated from the soil collected from the experimental plots in Beijing. Aldicarb was used as energy source for the development of the microorganisms. Among them, a Bacillus sp. (Bn-7) and a Fusarium sp. (Fl) were found most active for the degradation. The half-life of aldicarb as well as ^{14}C-(S-methyl)-aldicarb was 13.9 days in the Bn-7 culture media and 34.3 days in the Fl media. During a 30-day incubation, the degradation of the originally applied aldicarb sulfoxide and aldicarb sulfone in the Bn-7 culture media was 65.2 and 72.3% respectively. Aldicarb was rapidly oxidized to aldicarb sulfoxide in the culture media and followed by hydrolyzation to aldicarb sulfoxide oxime and aldicarb sulfoxide nitrile. After 47 days incubation, aldicarb and the two toxic metabolites disappeared almost completely.

METABOLISM OF CARBOFURAN IN GOSSYPIUM HIRSUTUM. Shu-ren Jiang (Beijing Agricultural University, Beijing, 100094, China)

^{14}C-ring- and ^{14}C-carbonyl-Carbofuran were used to treat cotton seedling via the root system for 3, 6 and 12 days. The stem and root of treated plants were respectively extracted with 80% and 50% methanol for 6 times. The concentrated extracts of the radioactive substances of different parts were separated by TLC. After development the thin-layer plates were evaluated with a scannograph. The residual plant materials after extraction were combusted in a sample oxidizer for quantitative determination of radioactivity.

The results of experiment showed: the main metabolites of Carbofuran in cotton seedling were 3-OH-Carbofuran and a unidentified polar compound. Interesting is that the ability of decarbonyl in the root was much stronger than in the stem.

AN OPTIMUM APPROACH OF WHEAT APHID AND NATURAL ENEMIES SYSTEM UNDER THE EFFECT OF PESTICIDE APPLICATION. Shi-ze Wang, Wen-jun Zhang (Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

The moving ideal point method was used to approach to optimazation on conditions that the ranges of X were limited, the weights (W) of every objective function were given. We obtainded the restults as following: The starting date of aphid population happenedded on 4.6 days after spraying; The peak date came on the 12th (check, 9652); The aphid number on the date of peak, was 168 per hundred plants (check, 894). In these circumstances, the increase ratio of wheat was 7.56%; the index of pesticide-12441.17; the standard number of natural enemies-90.7 per hundred plants (check, 177). Based on these, we think that: (1) The algorithm of moving ideal point is a simple method, to solve the problems of nonlinear and nultiobjective decision making, so, it could be useful to the designs for IPM. (2) The index of pesticide is a numbericle value, in which the ecological and economical effects are considered, in order to coordinate the relationship between pesticide and natural enemies, this index may extend into some fields of IPM. (3) Based on the solutions, the optimal spraying concentration could be obtained easy. It is considered that, the spraying concentration, or the absolute amount applied, should play an important role in the program of IPM.

EXTRACTION OF INDUCED ANTIBACTERIAL MATTER FROM HOUSEFLY HEMOLYMPH. Yuancheng Wang, Wei Liu, Feng Yang (Biotechnology Research Center, Chinese Academy of Agricultural Sciences, Beijing 100081, China), Guolei Feng (Institute of zoology, Academia Sinica, Beijing 100080, China)

The antibacterial matter was induced in housefly hemolymph by injecting Escherichia coli into the body cavity and by using ultrasonic method. The extraction method was described, and the activity and specificity of the antibacterial matter were detected. The results showed that both injection and ultrasonic methods were available for inducing antibacterial matter from housefly, and the activity peak value appeared at 60 hrs. after treatment. At 48 hrs. after treatment and 100 times'dilution, the lysozyme activity in hemolymph was 0.115 unit. The antibacterial matter inhibited the growth of E. coli, Staphlococcus aureus, Erwinia carotovora, Xanthomonas campestris and Bacillus thuringiensis, but no effect on Beauveria bassiana. Inducing effect of antibacterial matter on larvae was better than that on adults.

THE FUZZY SYNTHETIC DECISION MAKING FOR RESISTANCE OF WHEAT VARIETIES TO ENGLISH GRAIN APHID (*MACROSIPHUM AVENAE* (F.)). Shao-you Liu, You-ming Hou, Chong-sheng Gao (Department of Plant protection, Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

The resistancal index of 50 wheat varieties to English grain aphid (*Macrosiphum avenae* (F.)) are applicated in this paper to carry out the Fuzzy statistical regression analysis. The Fuzzy subordinate function of the resistancal index of wheat varieties to *M. avenae* as the quantity of aphid natural infection to wheat varieties (X_1), the rate of accumulated aphid survival (X_2), the period of average growth and development (X_3), the amount of average reproduction (X_4), the innate capacity rate of increase (R_m) (X_5), the harm resistance of wheat varieties (X_6) and so on are set up. The type of 5 Fuzzy synthetic decision model making for resistance of wheat varieties to *M. avenae* at varying operator are put forward. Through the Fuzzy synthetic decision making for the resistance of 10 wheat varieties to *M. avenae*, the results show that the resistance of cultivar Shaanxi 167 was the best, the next were 83(37)65, (87)113, 82246, the poor was Xiaoyan 6. The analysical results of decision are in agreement with the existing conditions. The results indicat that the Fuzzy synthetic decision model V (the type of synthetic), which had hight precision and much information, is the best.

RESEARCH ON INSECTICIDES FROM PLANTS IN CHINA. Shin-foon Chiu. (Laboratory of Insect Toxicology, South China Agricultural University, Guangzhou 510642, China)

An overview is presented on recent (1989-1991) investigations on insecticidal plants in China, specially South China. The main emphasis was layed on studies of Meliaceae including Azadirachta indica, Melia azedarach and M. toosendan, as well as on Rhododendron molle, Derris elliptica, Tephrosia vogelii, Ajuga nipponensis, Plumbago indica and Celastrus angulatus. Research work on the bioactivities and application of essential oils from plants for the control of stored grain insects is also presented. The results of these investigations reveal a great potential of the active ingredients of a number of Chinese plants for integrated pest management.as well as for using these natural product models as guides for the synthesis of a novel class of insecticides. Emphasis is placed on the research and application of insect growth regulators (IGRs) from plants.

THE EFFECTS OF NEEM OIL ON NYMPHS OF SCHISTOCERCA GREGARIA, LOCUSTA MIGRATORIA MIGRATORIOIDES, AND ZONOCERUS VARIEGATUS. H. Schmutterer, M. Baumgart, D. Freisewinkel, J. Langewald, C. Nicol (Institute of Phytopathology and Applied Zoology, Giessen University , Ludwigstr. 23, 6300 Giessen, Germany)

Neem oil causes a very strong, longlasting phagodeterrent effect in Schistocerca gregaria under laboratory, semi-field and field conditions. This effect is also pronounced in Zonocerus variegatus but relatively week in Locusta migratoria migratorioides. Z. variegatus and L. m. migratorioides show a reduced feeding activity after uptake of neem-oil contaminated food, resulting in a prolongation of the nymphal stage and smaller adults compared to control. The most spectacular effects of neem oil are mortality (mainly during moults after topical application), morphogenetic defects of antennae,legs and wings and change of colour of originally gregarious nymphs. Specially in Sch. gregaria, to a lesser extent also in L.m.migratorioides, nymphs become greenish or brownish like transiens and solitary forms. A supernumerary moult is also observed in some individuals of the desert locust. The fitness of the treated locusts (climbing and walking ability, etc.) is greatly reduced and their gregarious behaviour vanishes. The earlier the treatment takes place and the higher the azadirachtin content of the neem oil applied the stronger the above described effects. Scattering of bands of nymphs of Sch. gregaria and Z. variegatus was not only observed in the laboratory but also under semi-field and field conditions in Africa.

MODE OF ACTION OF BOTANICAL INSECTICIDES J.T. Arnason, (Department of Biology, University of Ottawa, Ottawa, Ont. Canada K1N 6N5)

Plant derived insecticides with non-neurotoxic modes of action promise to provide alternatives to conventional insect control agents that are likely to be environmentally acceptable as well as reduce the problem of cross resistance. The alternatives include light-activated substances, antifeedants, inhibitors of insect digestion and post-digestive physiology. New research on these will be discussed. Studies of light-activated substances are well advanced and predicition of the phototoxicity of thiophenic insecticides of the Asteraceae can now be made based on a quantitative structure activity model of their lipophilicity and ability to generate singlet oxygen.

BOTANICAL PEST CONTROL IN RICE-BASED CROPPING SYSTEM IN ASIA. R.C. Saxena(ICIPE, P.O. Box 30772, Nairobi, Kenya)

The use of plant derivatives for controlling insect pests affecting crops and stored grain has had a long history in Asia. Their use declined with the advent of synthetic insecticides. Since about 1980 there has been a renaissance of interest in plant derivatives for insect control to steer away from the problems spawned by destructive insecticide usage. Botanical pest control is no longer considered a primitive practice based on tradition or folklore. Stringent scientific scrutiny is proving it to be a biologically effective, ecologically sound, economically rewarding, and environmentally sustainable component of biointensive pest management. Problems encountered, progress made, and the potential of BPC in rice and rice-based cropping system in Asia are discussed in this paper.

GRAMINE AND ACONITIC ACID IN CEREALS PLANTS AS ANTIFEEDANTS TO APHIDS. Katsuo Kanehisa(Research Institute for Bioresources, Okayama University, Kurashiki, Japan)

There were resistant lines and susceptible lines in some cereal plants to aphids. Several substances in cereal plants were reported as antifeedants to pest insects. Gramine was found only in barley and a preceding component in alkali extract. The resistant lines had larger amounts of gramine, and always showed lower aphid populations. The susceptible lines had small amounts of gramine, and showed higher aphid populations. Decreases of gramine were followed by increases of aphids. Many corn lines, a resistant line of sorghum and a subspecies of barnyardgrass had larger amounts of aconitic acid, and they showed resistant property against aphids. A susceptible line of sorghum, two other subspecies of barnyardgrass, barley lines, wheat lines and rice lines had rather small amounts of aconitic acid. Their antifeeding activities were examined by adding to the artificial rearing solution, gramine showed more than ten times higher activity than aconitic acid.

ELETROPHYSIOLOGICAL STUDIES ON GUSTATORY CHEMORECEPTOR OF OSTRINIA FURNACALIS LARVAE FOR SEARCHING POTENTIAL ANTIFEEDANTS IN PLANTS. Zhi-zhen Shang, Wen-zhu Zhao, Yi-shi Zhu(Institute of Elemento-Organic Chemistry, Nankai University, Tianjin 300071, China)

The normal function and inhibitory responses of sugar receptor on Asiatic corn borer, Ostrinia furnacalis caterpillar was investigated using the eletrophysiological method. The gustatory chemoreceptor in larvae taste system was shown to be very sensitive and reliable as a bioassay-guided fractionations of antifeedants from plant origin, such as the crude extracts of Rhododendron molle, Wikstroconis indica and Dictamus dasycarpus etc. Inhibition of sugar receptors is an effective way to reduce feeding activity. This is the first attempt to use this technique which only requires small quantities of samples and the expe-riments can be accomplished in a short time on limited numbers of test insects, therefore, it is more convenient than the traditional behavioral bioassay method for searching potential antifeedants.

PEST CONTROL BY NATURAL PRODUCTS

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Extracts of certain Meliaceae species are used in folk medicine and also as pesticides in tropical and subtropical areas. We report on isolation by chromatography and structure determination by n.m.r. of a series of novel highly oxidized tetranortriterpenoids related to azadirachtin, vilasinin, nimbolide, nimbolinin, and sendanin, resp., from methanolic extracts of *Azadirachta indica, Melia azedarach, Melia dubia, Melia toosendan, Khaya nyasica,* and *Toona ciliata*, collected in India, Togo, Greece, Sri Lanka, China, South Africa, and Australia, respectively. Some of these compounds show remarkable antifeedant and/or insect growth regulating activities.

Structure activity relationships particularly with regard to azadirachtin and its analogues, and aspects of practical application of those natural products as pesticides will be discussed.

NEW SOURCES OF NATURAL INSECTICIDES FROM THE PLANT FAMILY MELIACEAE

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Crude plant extracts of over fifty species from the family Meliaceae have been screened for insecticidal and larval growth-inhibiting bioactivities via incorporation into artificial diets fed to the variegated cutworm, *Peridroma saucia* Hubner, a highly polyphagous noctuid. Samples of foliage, bark, fruits and wood, representing species in 15 genera, were collected in southeast Asia and Central America.

In addition to well known insecticidal species such as neem (*Azadirachta indica*) and closely related *Melia* species, some species in the genera *Aglaia* and *Cedrela* possess significant bioactivity against this pest insect. Active principles (phenolics and terpenoids) from these latter two genera have been isolated and identified. Results from preliminary investigations into modes-of-action, structure-activity relations, and spectrum of activity will be presented. Potential barriers to the commercial exploitation of these and other botanical insecticides will also be discussed.

INSECTICIDAL ACTIONS OF SEVERAL PHILIPPINE PLANTS WITH EMPHASIS ON *VITEX NEGUNDO*.

B. Morallo-Rejesus, H. Maini (Dept. of Entomol., Univ. of the Philippines at Los Banos, College, Laguna 4031, Philippines), F. Dayrit (Philippine Institute of Pure and Applied Chemistry Ateneo de Manila University, P. O. Box 154, Manila), E. Quintana (Dept. of Entomol., Univ. of the Philippines at Los Banos, College. Laguna 4031, Philippines)

Water and organic solvent extracts of 6 plants (*Tinospora crispa, Vitex negundo, V. trifolia var littoralis, Curcuma longa, Tithonia diversifolia, Derris* spp.) were evaluated for their insecticidal action against brown planthopper, green leafhopper, diamondback moth, corn borer and rice stemborer. Water extracts of *T. crispa* showed systemic and ovicidal toxicities (OT) and growth inhibitory effect (IGR). *V. negundo* and *T. diversifolia* showed contact and ovicidal toxicities and IGR effect. *Derris* spp. and *C. longa* showed contact and ovicidal toxicities. Hexane (HE) and six volatile oil (VC) fractions of *V. negundo* were further evaluated for larval and ovicidal toxicities on DBM. Three HE and VO fractions were topically toxic to the larvae. The ethyl acetate extract caused larval abnormalities on DBM and corn borer. Isolation and identification of active principle(s) is in progress.

LABORATORY AND FIELD EFFICACY OF NEEM EXTRACT AGAINST TWO BROCCOLI PESTS.

Errol Hassan, Djoko Prijono(Senior Lecturer in Plant Protection ,The University of Queensland, Gatton College, Lawes Queensland 4343, Australia)

In the laboratory, instar III and IV (final) of *Corcidolomia binotalis* Zeller (Lepidoptera: Pyralidae) were fed neem extract- and/or azadirachtin-treated broccoli leaves for 24 and 48 h, respectively, then their development was followed until pupation and adult emergence. The effects in the tests with the third and fourth instar were recorded in four and five categories, respectively. Polytomous binary response analysis based on the conditional binomial model revealed that, within particular concentration ranges, both in the tests with the third and fourth instar the probabilities of occurrence of effects in all categories were concentration dependent. The median moulting inhibitory concentrations (IC_{50}) of neem extract and azadirachtin on the third instar were 0.27% and 43.9 ppm, respectively. IC_{50} of neem extract on the fourth instar was 0.065%.

In the field, neem oil at rates of 1.8-3.0 l/ha gave comparable control of *Plutella xylostella* L. (Lepidoptera: Yponomeutidac) on broccoli as Sumicidin (R) 200 (250ml/ha). In addition, neem oil at the same rates could check, though not completely, the build up of *C. binotalis* population.

POTENTIAL OF THE CHINESE BITTERSWEET, *CELASTRUS ANGULATUS* FOR INSECT PESTS CONTROL.

Wen-jun Wu (Department of Plant protection, Northwestern Agricultural University, Yangling, Shaanxi 712100, China)

The Chinese bittersweet *Celastrus angulatus* Max., which is widely distributed in China is a potential botanical insecticide. Its root bark contains much more bioactive materials compared with the other parts of the plant, is suited to formulations of wettable powder or emulsifiable concentrate for insect pest control. The results of the field plot experiments showed that the damage of *Pieris rapae, Parnara guttata, Athalia flacca, Semiothisa cinerearia* and *Aulacophora femoralis* etc. could be controlled effectively by application of the preparations.

A novel insect antifeedant, Celangulin, and three new compounds which had strong poisonous action against armyworm were isolated from the root bark of the plant, and their molecular structures also were determined by NMR and mass spectrometry. All these compounds were new β—dihydroagarofuran sesquiterpene polyol esters.

DESIGN OF INSECT CONTROL AGENTS BASED ON NATURAL MODELS. Hirosuke Yoshioka (Institute of Physical and Chemical Research, Wako, Saitama 351-01, Japan)

Insecticides design from models known as natural bio-regulators being a highly important approach to new lead generation, there is ever-existing difficulty owing to the high structural multiplicity that hampers prompt trials by chemical synthesis. Examples are models of higher terpenoids or steroids, poly-cyclic phenolics, macrolides, or some others with complex rigid skeletons or sub-structures in non-linear combinations, most of which still remain undeveloped to date. The difficulty should be much reduced if designs could be so made as to generate trial structures of more linear combination in a flexible formation. To facilitate this strategy, a series of new procedures have been devised, in which pyrethroids were taken up as probe to gather and integrate common architectural images from diversified analogs with same mode of action, then to reorganize them on a format or "hexagonal grid matrix" into schematically reformed models superimposed with each other. The procedures were then applied to correlating natural respiratory inhibitor models with various synthetic insecticides having a similar mode of action. Recent views for designing respiratory inhibitor insecticides are discussed.

SILAFLUOFEN - A PROMISING NEW TYPE OF INSECTICIDE. CHARACTERISTICS AND POTENTIAL OF THIS SILICON-CONTAINING INSECTICIDE.
Kern, M. J., Lourens, J., Sagenmüller, A., Schubert, H., and Gunjima, K. (Hoechst AG, Agricultural Division, P.O.Box 800320, D-6230 Frankfurt 80, Germany)

Silafluofen, a new insecticide form Hoechst AG, has been characterised in mode of action studies and selectivity tests with pest species and beneficial insects, and its efficacy has also been documented by the results of field trials in agro and non-agro uses.

The data presented here will show that Silafluofen posesses a specific insecticidal mode of action differing in various parameters from that of conventional insecticides. The specific properties of this compound (selectivity) are manifested in its efficacy (laboratory trials) against different target pests, such as Nilaparvata lugens or Coptotermes formosanus, as compared with the effects on beneficial insects such as Lycosa pseudoannulata and predacious mites such as Amblyseius longispinosus.

Data from our field trials show that Silafluofen offers excellent prospects for the control of pest both in rice and in the wood protection and hygienic sectors.

NOVEL SELECTIVE INSECTICIDES - PROSPECT AND POTENTIAL USE FOR CONTROLLING AGRICULTURAL PESTS. Isaac Ishaaya and Doron Baum (Dept. of Entomology, ARO, The Volcani Center, Bet Dagan Israel)

IGRs and chemicals with novel modes of action, affecting selectively various groups of insects are under advanced research and application. Benzoylphenyl ureas such as teflubezuron (TFB) and chlorfluazuron (CFA) are potent compounds against lepidopterous pests such as Spodoptera littoralis, Lobesia botrana and Cryptoblabes gnidiella. Under standard laboratory conditions the LC-50 values of CFA, TFB and diflubenzuron for L. botrana were 0.39, 0.37 and 181.70 ppm, respectively, and those for C. gnidiella were 0.81, 0.76 and 31.00 ppm, respectively. Under field conditions, CFA and TFB gave better control than the standard OP compounds. Buprofezin, a novel IGR acting specifically on some homopteran pests is effective for controlling whiteflies, planthoppers and scale insects.

In addition to the above compounds, the JHA pyriproxyfen is a powerful insecticide for controlling the sweetpotato whitefly Bemisia tabaci. It suppresses embryogenesis and adult formation. Diaphenthiuron, a new type of thiourea acting specifically on phytophagous mites, whiteflies and aphids was found to affect all stages of B. tabaci. The pyrrole compound (AC-303,630) acting specifically on lepidopterous pests and the pyrazole derivative (AC-801,757; MK-239) acting on phytophagous mites are under advanced research and application.

The above compounds are potential for controlling agricultural pests with minimum hazard to the environment.

DEVELOPMENT OF FENPYROXIMATE, A NEW ACARICIDE.
T. Konno, O. Kajihara and H. Hamaguchi (Nihon Nohyaku Co., Ltd., Research Division, 4 - 31 Honda - cho, Kawachinagano, Osaka 586, Japan)

Fenpyroximate is a promising novel acaricide characterized by a new phenoxy pyrazole constituent. It is already registered in Japan, China and a few European countries and is now under development in other areas with the code number of NNI - 850.

The chemical shows selective activity on important phytophagous mites such as Tetranychidae, Eriophyidae and Tarsonemidae with compatible property for IPM practices. It provides excellent control efficacy on field populations including those resistant to conventional acaricides by means of outstanding knockdown and residual activity without any phytotoxicity to many kinds of crop at doses of as low as 25 - 50 ppm. The chemical also inhibits molting of immature stages of mites at sub - ppm doses, suggesting its different mode of action from those of other chemicals.

Upon development of an acaricide to which mites can develop resistance quite easier in general, a rapid bioassay - method has been already established for Tetranychidae, based on the unique biological properties of fenpyroximate. The monitoring of the susceptibility of field populations to the chemical can be conducted at sites and such attempt may be quite useful for the resistance management.

Caterpillar Selective Non-Steroidal Ecdysone Agonists

Glenn R. Carlson, Harold E. Aller, J. Roger Ramsay, Richard Slawecki, Muthuvelu Thirugnanam and Keith Wing. (Rohm and Haas Research Laboratories, Spring House, PA 19477)

The benzoylhydrazines are the first non-steroidal ecdysone agonists. Leading members of this series are effective, highly selective caterpillar control agents. These compounds are more amenable to synthesis, more chemically robust, and more toxic to caterpillars than any of the naturally occurring ecdysteroids. They are also more caterpillar selective, faster acting, and more plant systemic than other insect growth regulators (IGRs), and safer to the non-insects than most neuroactive insecticides.

EFFECTS OF 1,5-DISUBSTITUTED IMIDAZOLES ON DEVELOPMENT AND DIAPAUSE IN INSECTS. Eiichi Kuwano, Morifusa Eto (Dept. of Agricultural Chemistry, Kyushu University, Japan), Koichi Suzuki (Faculty of Agriculture, Iwate University, Japan)

A large number of 1,5-disubstituted imidazoles induced clear precocious metamorphosis in larvae of the silkworm, Bombyx mori, which was reversed by not only treatment with methoprene, but also dietary administration of 20-hydroxyecdysone. None of compounds induced precocious metamorphosis in the large milkweed bug, Oncopeltus fasciatus, however, several 1-isobutyl-5-substituted imidazoles showed delayed toxicity. In most instances, the treated nymphs died during or immediately after the molt. There was no apparent correlation between the ability of imidazoles to cause precocious metamorphosis in B. mori and the delayed toxicity in O. fasciatus.

1-Benzyl-[(E)-2,6-dimethyl-1,5-heptadienyl] imidazole (KK-42), most effective compound for B. mori larvae, terminated the diapause in the larvae of pharate first instar in the silkmoth, Antheraea yamamai and the gypsy moth, Lymantria dispar japonica. A number of 1,5-disubstituted imidazoles showed activity comparable to that of KK-42 against the diapausing larvae of the silkmoth.

THE ASYMMETRIC SYNTHESIS OF THE SEX PHEROMONE OF SEMIOTHISA CINEREARIA BREMER ET GREY IN CHINA
Zheng-Ming Li, Sheng-Xin Wang, En-Yun Yao, Zhi-Zhen Shang (National Key Laboratory of Elemento-Organic Chemistry, Nankai University, Tianjin, China)

Semiothisa cinerearia is a defoliator of Sephora japonica L. in China. In 1987 in our laboratory the structural elucidation of its sex pheromone gland was undertaken. After excision of its gland, the extracted solution was further isolated and purified by preparative GC. The active component, monitored by EAG, was identified for the first time as 3,4-epoxy-(Z,Z)-6,9-heptadecadiene. Seven synthetic steps were carried out starting from heptyl bromide to obtain a key intermediate- hexadecatrienol, from which by asymmetric epoxidation to obtain 3S,4R-3,4-epoxy-(Z,Z)-6,9-hexadienol ($[\alpha]^{20} = +9.8^{\circ}$ in $CHCl_3$). By an organo-copper reagent an optical target molecule ,(3S,4R)-3,4-epoxy-(Z,Z)-6,9-heptadecadiene, was obtained. The preliminary EAG result was discussed.

BIOCHEMICAL APPROACHES FOR THE LEADS OF INSECT CONTROL AGENTS. Morifusa Eto (Department of Agricultural Chemistry, Kyushu University, Fukuoka 812, Japan)

Insect biochemistry provides a very valuable source of leads for insect control agents. Bioorganic chemistry is powerful tool for approach. Researcher's attitude and efforts to learn from organisms at every step of the exploitation are required. The suitable screening is always important, resulting often in serendipitous discoveries of precious leads.

Many insect control agents consist of a functional moiety which interacts directly with the active site of a target biomacromolecule and of an accessary moiety which is concerned in the affinity with a particular enzyme or receptor, biodegradability, permeability, and photostability of the molecule. New lead compounds for the desired biological activity should be designed by the rational combination of the two moieties based on bioorganic chemistry and biochemistry. However, unexpected results involve often a clue to very useful discovery.

Cyclic organophosphorus insecticides and insect growth regulators discovered in our laboratory will be discussed as examples.

NEW APPROACHES TO BACILLUS THURINGIENSIS AND THURINGIENSIN INSECTICIDES. Y. Wang (Abbott labortories, 1401 Sheridan Road, D-451 RIB, North Chicago, Ill. 60064, U.S.A.)

The delta-endotoxin (Insecticidal Crystal Protein) and the Beta-exotoxin (thuringiensin metabolite) of *Bacillus thuringiensis* bacteria are effective microbial and biochemical insecticides to control forestry and agricultural pests as well as vectors (mosquitoes and black flies) of human disease. Recent advances in genetic engineering, fermentation development and formulation technology have led to improved biological effectiveness, spectrum of activity, product stability and application methods and consequently greater commercial success and market expansion.

So far, there are over 30 naturally occuring *Bt* subspecies or varieties containing four classes of ICP genes, and two types of metabolites plus several recombinant systems have been recognized. The latest development of *Bt* protein genes, ICP mode of action, and quantitative protein and insect assays will be reviewed and discussed with special emphases on formulation and product improvement.

DYNAMIC INTERFACIAL PROPERTIES OF OIL/WATER/SURFACTANT SYSTEMS. Paul D. Berger (c/o Witco Corporation, 3200 Brookfield, Houston, TX 77045, USA)

Dynamic Interfacial Tension studies were conducted on systems containing anionic and nonionic emulsifiers to determine their effect on emulsion stability, droplet size. The influence of temperature and electrolyte concentration as well as the order of addition and the phase in which the surfacetant is dissolved was also studied. The application of this study to water-based aerosol sprays will be discussed.

PVC RESIN FORMULATIONS OF PHEROMONES FOR CONTROL OF COTTON AND RICE PESTS BY MATING DISRUPTION. Alan Cork (Natural Resources Institute, Chatham Maritime, Kent, ME4 4TB, U.K.)

A PVC resin formulation was developed for use in controlling lepidopterous pests by the mating disruption technique. Advantages of the formulation over other commercially available formulations include ease of manufacture from inexpensive pre-polymers and the ability to incorporate and protect a wide range of lepidopterous pheromone components, including conjugated dienes and aldehydic compounds.

Release rate characteristics of a wide range of lepidopterous pheromone analogues incorporated into the PVC resin formulation were studied in a wind tunnel and in the field by GC analysis of residual pheromone. The results showed that compounds were released by first order kinetics that are influenced by chain length, chemical functionality, temperature, loading and dispenser shape.

Field trials with PVC resin formulations incorporating the sex pheromones of cotton bollworms *Pectinophora gossypiella*, *Earias insulana*, and *Earias vittella* in Pakistan and the rice stem borers *Chilo suppressalis* and *Scirpophaga incertulas* in Spain and India respectively demonstrated the efficacy of the PVC resin formulation for season long control of these pests by mating disruption.

INFLUENCES OF FORMULATION AND APPLICATION TECHNOLOGY UPON PESTICIDE DEPOSITION. Yu-qin Tu (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Biological efficacy of pesticide is generally in close relationship with effective contact (EC) and deposition rate (DR) of spray solution on target surface. EC and DR are affected and determined by formulation, environmental conditions and application technology, in which formulation plays a fundamental and important role. The main attention was focused on wettability and retentivity of spray solution on plant leaf surface in our laboratory. It was found that wettability should be adjusted to an optimum but not highest level so that a good deposition could build up. Cotton leaves are easily wetted by water, a very low concentration of dodecylbenzenesulfonate (DBS), 50ppm, caused serious drainage which decrased DR on leaves. But on cucumber leaves at least 400ppm of DBS is necessary to wet leaf surfaces, otherwise running-off of spray drops will occur, and this also weakens DR. A fine spray with VMD around 50μm enhanced DR even under low wettability. Recovery of carbendazim from wheat ears was elevated to 20.18% by fine spray but only 7.04% by conventional coarse spray under same wettability, and only 5.31% for coarse spray and 11.5% for fine spray if wetting agent is absent.

The Application of Modern Granulation Technology in Pesticide Formulation. **K. C. Lin** **(ICI Americas Inc., Richmond, CA 94804**

In recent years, due to issues such as government regulation, handling safety, packaging disposal, cost of insurance and warehousing and user's preference, etc., the solid formulation has become one of the favorable product forms. This presentation will give an overview on the various types of granulation technologies and their applications to pesticide formulation.

Two types of solid pesticide formulations that have gained interest are the water dispersible granule (WG) and water soluble granule (SG). The mechanisms of particle size enlargement will be discussed. Several kinds of granulation technologies and their features as well as advantages/ disadvantages will also be discussed.

INSECTICIDAL CHARACTERISTICS OF *d*-CYPHENOTHRIN MICROCAPSULE FOR COCKROACH CONTROL. Kawada, H.; Ohtsubo, T.; Tsuda, S.; Abe, Y.; Tsuji, K. (Agricultural Science Research Laboratory, Takarazuka Research Center, Sumitomo Chemical Co., Ltd., Takarazuka, Hyogo *665*, Japan)

d-Cyphenothrin (Gokilaht®), which was evolved during the structural modification for *d*-phenothrin (Sumithrin®), has a high insecticidal activity. *d*-Cyphenothrin is characterized by its higher toxicity against cockroaches as compared with permethrin.

Encapsulation of *d*-cyphenothrin with the proper particle size and wall thickness was found to reinforce the residual activity especially on the absorbent surfaces. *d*-Cyphenothrin microcapsule is photo-degradable under room conditions and gives proper residual efficacy with lower pressure for development of resistance.

Elsewhere, we examined the effect of formulation factors of fenitrothion microcapsule on the insecticidal efficacy and its way of action, finding that the "trampling" and "ingestion" of microcapsules are the main modes of entry. With *d*-cyphenothrin microcapsule, on the other hand, the ingestion of microcapsules was suggested to be minor because of lesser oral toxicity of *d*-cyphenothrin.

FIELD AND LABORATORY STUDIES TO EVALUATE THE SIDE EFFECTS OF DIFFERENT INSECTICIDES ON SPIDERS IN WINTER WHEAT FIELDS. Axel Dinter & Hans-Michael Poehling (Institut für Pflanzenpathologie, Grisebachstr. 6, W-3400 Göttingen, Germany)

Side effects of Pirimor (Pirimicarb), Sumicidin 10 (Fenvalerate) and Karate (Lambda-Cyhalothrin) on spiders were studied in lab tests and in field experiments from 1989 to 1991 when the insecticides were applicated between ear emergence and milky ripe stage of winter wheat.

According to the lab studies (spraying, topical application) Sumicidin 10 and Karate are highly and dose dependant toxic to *Erigone atra* (B.) and *Oedothorax apicatus* (B.) (Araneae; Linyphiidae). Individuals of *Erigone atra* were more sensitive than those of *Oedothorax apicatus* and males of both species were more susceptible than females. Under field condition Sumicidin 10 and Karate caused a several weeks lasting reduction of the activity density of males of *Erigone atra* acertained by pitfall trapping. Instead comparable persistent effects on the population density of adults of *Erigone atra* couldn't be detected by repeated intensive vacuuming of field areas of 0,25m^2 with a D-vac suction machine, but nevertheless there were effects of smaller dimension. Furthermore juvenile spiders can be strongly reduced by Sumicidin spraying. In contrast Pirimor application caused no or only slight increased mortality of the test species in the lab or field tests.

ECOLOGICAL BASIS OF POME FRUIT ORCHARDS IPM SYSTEMS Brian A. Croft (Department of Entomology, Oregon State University, Corvallis, OR 97331)

Recent losses and lack of registration of non-selective pesticides has forced pome fruit growers to adopt more selective measures of plant protection. Pesticide resistance management which take into account arthropod movement and gene flow of resistance traits are helping to increase the use-life of some highly selective miticides and management of insecticide-resistant biological control agents. Mating disruption and use of juvenile hormone-type compounds have allowed for increased levels of biological control of aphid, mite, leafminer, and scale pests by complexes of predators and parasitoids. Competition or interspecific interaction studies of beneficials are adding insights into key natural enemy associations. Spatial studies of the population dynamics and immigration of key pest and natural enemy groups are helping identify the risk of pest problems and possibilities for biological control. Use of alternative host plants and augmentation of natural enemies is also leading to enhanced biological control. A community approach to arthropod pest and natural enemy management is now more feasible in many pome fruit orchard ecosystems.

Pesticide Degradation Products: Fate and Significance in the Environment
L. Somasundaram and J. R. Coats, Pesticide Toxicology Laboratory, Department of Entomology, Iowa State University, Ames, Iowa 50011, U.S.A.

Pesticides applied in the environment are transformed by biological or nonbiological processes into one or more transformation products. For most pesticides, transformation results in detoxification to innocuous products. Major degradation products of some currently used pesticides, however, play an important role in pest control and environmental contamination. The pesticidal properties, persistence, degradation, and groundwater contamination potential of major degradation products of commonly used pesticides will be presented. The role of degradation products in risk assessment and pesticide regulation will be discussed.

ROLE OF ELECTROSTATICALLY CHARGED SPRAYS TO REDUCE DOWNWIND CONTAMINATION OF ADJACENT CROPS
By G.A. Matthews, Imperial College of Science, Technology and Medicine, Silwood Park, Ascot SL5 7PY, UK.
Concern about pesticide spray drift resulting in environmental pollution has led to categorising spray quality of nozzles which is defined by comparing the droplet spectra of selected reference nozzles measured with a laser light diffraction analyzer. However there is a conflict between a need for small droplets for increased biological efficacy and large droplets to reduce downwind drift. Registration authorities tend to favour a coarser spray with large droplets, but drift can be reduced with small droplets by electrostatically charging a spray. The charged spray needs to be released close to the crop to avoid the upward dispersion of droplets within a spray cloud due to mutual repulsion and exacerbated by convective air movement. Increased deposition of charged sprays on the crop foliage is associated with less soil contamination which allows greater survival of ground dwelling predators. This feature needs to be exploited by growing relatively narrow strips of crops so that if one crop needs a pesticide treatment, natural enemies can be conserved in adjacent untreated crops. By careful selection of insecticides and dosage rates, these predators should be able to recolonise the treated area and thus integrate chemical with biological control.

ENHANCED BIODEGRADATION OF SOIL-APPLIED PESTICIDES IN AGROECOSYSTEMS. Allan S. Felsot, Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, Illinois 61820, USA

Initially an obscure laboratory phenomenon, enhanced biodegradation of soil-applied pesticides has grown to be a major phenomenon that can adversely effect the successful control of soil-borne pests. Both field and laboratory observations have definitively proven that repeated treatment of soil with many classes of herbicides, insecticides, and fungicides can result in increased degradation rates upon subsequent applications of the same pesticide or chemically related analogs. The significance of enhanced biodegradation in agroecosystems, however, is many times obscured by a lack of recognition that it is even occurring. Most soil pesticides are used prophylactically, so farmers will not notice control problems unless pests are present above the economic injury level. Any attempts to control biodegradation of pesticides must be done with great care so as not to prolong persistence past the time of optimal need. The best strategy for managing enhanced biodegradation is learning how to cope with it or alternatively avoiding the development of the phenomenon altogether.

How enhanced biodegradation develops is somewhat controversial. Some researchers believe that microbial populations with pesticide-degrading capabilities rapidly proliferate in response to energy derived during metabolism of the pesticide. Other workers have noted minimal increases in microbial numbers and have hypothesized that enhanced biodegradation results from an adaptive physiological response to the pesticide, perhaps enzyme induction. The real explanation lies in a combination of these ideas, but the disagreement proves there is much to be learned about the phenomenon. Minimal effort has been made in understanding ecological differences between soil types and the factors affecting the development of the process. An understanding of the molecular biology of enhanced biodegradation of the carbamate pesticides is beginning to emerge, but little is known about the many other compounds known to stimulate microbial adaptations. Further studies on all aspects of enhanced biodegradation would constitute more than just passing curiosities; knowledge gained by studying enhanced biodegradation in agroecosystems will be useful for development of practical bioremediation systems to detoxify pesticide waste.

AEROBIC VERSUS ANAEROBIC DEGRADATION OF PESTICIDES IN SUBMERGED SOILS. *N. Sethunathan, T.K. Adhya, S. Bhuyan, D. Misra, S.K. Sahu (Central Rice Research Institute, Cuttack 753006, India)*

A submerged soil especially planted to rice is a unique system with a dynamic and microbially active aerobic-anaerobic interface and can serve as an effective medium for both aerobic and anaerobic transformations of many pesticides. In flooded soils isomers of hexachlorocyclohexane (HCH) are degraded by anaerobic bacteria after first application and also by aerobic bacteria due to their build-up after multiple applications. Cometabolism was implicated in the anaerobic degradation of α- and γ-HCH. In contrast, aerobic bacteria degraded α- and γ-HCH by metabolism and β- and δ-HCH by cometabolism. Almost all the chlorine in HCH was released as chloride during degradation by both aerobic and anaerobic bacteria. Degradation of phosphorothioate insecticides, methyl parathion and parathion in flooded soil involved nitro group reduction by anaerobes after first application and hydrolysis by aerobes after multiple applications. Accelerated aerobic biodegradation of organochlorine (HCH isomers) and phosphorothioate insecticides can lead to problems of decreased efficacy after their repeated applications to tropical rice paddies.

FATE OF CHLORPYRIFOS AND CYPERMETHRIN IN ELM BARK, LITTER, AND SOIL. Heng Jin and G.R.B. Webster (Pesticide Research Laboratory, Department of Soil Science, University of Manitoba, Winnipeg, MB, Canada R3T 2N2), N.J. Holliday (Department of Entomology, University of Manitoba, Winnipeg, MB, Canada R3T 2N2), and R.A. Westwood (Forestry, Manitoba Natural Resources, Winnipeg, MB, Canada R3N 1Z4)

The bottom one metre of the trunks of three sets of elm trees, *Ulmus americana* L., at two riverbank forest sites were treated with 100 x dilution of 48 EC Dursban (chlorpyrifos) or 400 x dilution of 40 EC Ripcord (cypermethrin) to runoff as part of an experimental program to control overwintering native elm bark beetles, *Hylurgopinus rufipes* (Eichh.), the principal vector of Dutch elm disease, *Ceratocystis Ulmi* (Buism.) C. Moreau. Samples of elm bark, litter, and soil were collected at prearranged intervals over a 10 month period to investigate the degradation and fate of chlorpyrifos and cypermethrin in these samples. Analytical methods will be described for the determination of chlorpyrifos and its main metabolites, and the four isomers of cypermethrin and their main metabolites in elm bark, litter, and soil matrices including their identification using ion trap GC-MS. The decline of the parent compounds and the formation of metabolites in the above matrices will be described.

STUDY ON DEGRADATION OF MALATHION, FENITROTHION, PIRIMIPHOS METHYL AND DELTAMETHRIN IN STORED GRAIN. Guo-Liang Zhang (Grain science Research Institute of Zhejiang Province, Hangzhou 310012, China) Ze-bing Wang (Zhejiang University, Hangzhou 310027, China), Guo-ying Yu, Jiang Liu (Grain Science Research Institute of Zhejiang Province, Hangzhou 310012, China)

At 30°C laboratory condition, malathion, fenitrothion and pirimiphos methyl in rice, the half life of residual degradation ($t_{1/2}$) was 1, 2.3, 3.7 months respectively. In granary condition in wheat, the malathion $t_{1/2}$ was 5.4 months and deltamethion was 15.6 months. When grain was treated by rice-hull-carrier method, the dynamics of residual degradation was in two exponential equation reaction. And pesticides sprays directly on grain, was in first order reaction. The residual amount in polished rice and cooked rice were significantly lower than in wheat flour and steamed bread.

DISSIPATION AND MOVEMENT OF CHLOROBENZILATE IN THE ENVIRONMENTS. Yei-Shung Wang, Shin-Wei Chen, Yuh-Lin Chen (Department of Agricultural Chemistry, National Taiwan University, Taipei, Taiwan, China)

Chlorobenzilate (ethyl 4,4'-dichlorobenzilate) was relatively easily dissipated from the soils in the laboratory experiments. In the soil of 90% field capacity moisture under 25 C for 21 days, the residue of chlorobenzilate was 14 and 55% for Lukang silty clay loam (pH 7.2; organic matter 2.0%) and Pincheng clay (4.7; 0.5%), respectively. While in river water for 34 days, 60 and 29% of chlorobenzilate remained in Green Lake river water (pH 7.2; DO 8.7 mg/L) and Wai-Shuang-Shi river water (7.3; 6.1 mg/L), respectively, at adjusted river water to pH 9; but more than 80% of chlorobenzilate remained in the water from both rivers by adjusted to pH 5 and in natural water. Dissipation rates of chlorobenzilate in Lukang soil are higher than in Pincheng soil under the same conditions; the rates increased as the temperature or soil moisture increased. Chlorobenzilate was difficult to leaching in soil. In a soil column experiment, chlorobenzilate were retained in the upper 3 cm of soil column.

A REVIEW OF THE ENVIRONMENTAL FATE OF "KUNG FU" A SYNTHETIC PYRETHROID INSECTICIDE IN SOIL AND WATER
S Parker (ICI Agrochemicals, Jealott's Hill Research Station, Bracknell, Berkshire, RG12 6EY, UK.)

Scientists first isolated and identified the natural pyrethrins responsible for the insecticidal activity of pyrethrin flowers, over two decades ago. Since their discovery, synthetic chemists have endeavoured to create photostabilized synthetic pyrethroids with even greater activity. A notable success in this area has been the discovery and development of lambda-cyhalothrin, commercial name "Kung Fu".

Using ^{14}C-radiolabelled techniques, metabolism chemists have conducted laboratory and field based studies to investigate the environmental fate of lambda-cyhalothrin. For the purposes of this paper and presentation, attention will be focused on the behaviour of lambda-cyhalothrin in soil and water. In particular hydrolysis, photolysis, adsorption/desorption, leaching and soil metabolism will be reviewed. The experimental systems used to investigate the rate of degradation, the processes involved and the products generated will be described. The implications of these data on the insecticidal activity and environmental impact of lambda- cyhalothrin will be discussed.

DEGRADATION OF FOUR ORGANOPHOSPHORUS INSECTICIDES IN DIFFERENT TYPES OF SOIL. Chuanfan Qian, Lu Yu (Department of Agricultural Applied Chemistry, Beijing Agricultural University, Beijing 100094, China)

The degradation and half life of methyl isofenphos, parathion, quinalphos and malathion in six different types of soil were studied. 24 degradation curves of insecticides were shown. The average half lives in the six types of soil were: 26 days for methyl isofenphos, 22 days for parathion 15 days for quinalphos and 6 dyas for malathion. In the soil methyl isofenphos is more persistent than the others. Difference in soil types had much less influence on the rate of degradation of methyl isofenphos than on that of the other three insecticides. The half lives of the former one varied only from 20 to 30 days, while those of the latter three varied greatly.

Other factors influencing the rate of degradation of methyl isofenphos such as temperature and humidity were studied. They are also important factors affecting the activity of microorganisms.

PREDICTING AND OBSERVING FATE OF SPRAYS RELEASED OVER FORESTS

John W. Barry & Milton E. Teske (USDA Forest Service, 2121C 2nd St., Davis, CA 95616 USA)

The FSCBG (Forest Service Cramer-Barry-Grim) computer model has been developed for forestry application and is also well suited for agriculture and vector control applications. The model predicts deposition, dispersion, drift, and evaporation of aerial sprays as a function of model inputs. The inputs include description of the aircraft, spray system atomization, meteorology, tank mix formulation, and vegetation. FSCBG has been developed and evaluated with field data from both control experiments and operational projects. This paper reviews results of these development and evaluation activities, and suggests how the model can be used in conjunction with environmental fate models that predict fate of pesticides in soil and water.

DEPOSITION, PERSISTENCE AND FATE OF BACILLUS THURINGIENSIS VAR KURSTAKI IN A HARDWOOD FOREST, AFTER AERIAL SPRAYING OF A COMMERCIAL FORMULATION AT TWO DOSAGE RATES. Alam Sundaram, K.M.S. Sundaram (Forestry Canada., Forest Pest Management Institute, 1219 Queen Street East, Box 490, Ontario, Canada P6A 5M7), N.R. Dubois (United States Dept. of Agriculture, Center for Biological Control, Northeastern Forest Experiment Station, 51 Mill Pond Road, Hamden, Connecticut 06514, USA), B.D. Hammock (University of California, Department of Entomology, Davis, California, 95616, USA).

A commercial formulation of Bacillus thuringiensis var kurstaki (B.t.k.), Foray 48B, was sprayed over four blocks in a hardwood forest, two blocks at 75 BIU in 5.91 L/ha and the other two at 50 BIU in 3.94 L/ha, using a fixed wing aircraft equipped with rotary atomizers. Spray deposits of B.t.k. were assessed on oak foliage by bioassay and immunoassay methods. The initial deposits (expressed in IU/cm^2) were lower in blocks that received the higher volume rates than in blocks that received the lower volume rates. The bioactivity of B.t.k. persisted only for a short period of time (less than a week) in all four blocks. The half-life of inactivation, DT_{50}, ranged from ca 12 to 22 h, and was not related to the amount of intial deposits on foliage. A laboratory study, conducted using oak seedlings showed that the rate of inactivation was inversely dependent on the drop size of deposit on foliage. This is perhaps due to the greater area of exposure to sunlight when a known amount of protein was present in several small drops, than when present in a few large drops.

PREDICTION ON THE DEGRADATIVE RATE OF PESTICIDE RESIDUE ON TEA PLANT. ZONG-MAO CHEN, HAI-BIN WAN, HUI-LOMG XIA(Tea Research Institute, Chinese Academy of Agricultural Sciences, Hangzhou 310008 Zhejiang, China.)

The fate and transfer of pesticide in the process between the pesticide sprayed on the tea plant and come into the tea infusion are gone through the following three stages, i.e.:degradation in the field condition. degradation during the manufacturing process and extractive rate during the brewing process. The degradative rate of pesticide on in tea shoots can be predicted from the volatilization rate, photodegradation rate, rainfall elution and growth dilution of tea shoots. The degradative rate of pesticide in the fresh leaves during the manufacturing process can be predicted by the vapour pressure of pesticide. The extractive rate of pesticide in made tea to tea infusion during the brewing process can be predicted by the water solubility of pesticide. Different pesticides belonged to the groups of orgnophosphate, organochorine and pyrethroids were selected in this investigation. The predictive model of above mentioned degradative factors and the predictive technique on the residue level of various pesticides in tea shoots and made tea duirng the different date after the spraying of pesticide as well as the concentration of pesticide in tea infusion were suggested.

CANADIAN REGULATORY ASPECTS OF PESTICIDE REGISTRATION WITH EMPHASIS ON THE ADOPTION OF NATURALLY OCCURRING AND GENETICALLY MODIFIED PEST CONTROL PRODUCTS.

W.P. Cochrane & J.E. Hollebone (Food Production and Inspection Branch, Agriculture Canada, Ottawa, Ontario, Canada, K1A 0C6)

Pest control products, including microbial agents such as Bacillus thuringiensis, must be registered before sale and use in Canada in compliance with requirements established under the authority of the Pest Control Products Act and Regulations. In addition, before release to the environment is permitted research permits must be approved which set the conditions and limitations for field testing. Data requirements to support field testing and registration include: proposed use, human health safety testing including acute toxicity/infectivity/hypersensitivity tests, food and feed residue studies, environmental fate, toxicity to non-target organisms and performance data.

Currently, guidelines for naturally occurring microorganisms are being revised to also include genetically engineered organisms (GEO's). The approach is to compare the GEO to its conventional relatives and evaluate any differences.

METHODOLOGIES FOR ASSESSMENT OF CHEMICAL FATE. D. A. Laskowski (Environmental Fate Group, DowElanco, 9001 Building, Midland, MI, USA, 48641-1706)

The science of environmental chemistry has matured considerably over the last 20 years. Initially assessment of fate of agricultural chemicals was performed exclusively through observation via analytical monitoring programs. As knowledge grew, certain key environmental properties that govern environmental fate were identified, and assessment was made more predictive by comparison of these properties for unknown chemicals with those chemicals of known fate through the process of benchmarking. This technique is popular at present, but is making way for new methods that involve prediction of fate through mathematical modeling of the processes responsible for environmental fate. Through recent innovations in modeling, it is possible to predict the likelihood for environmental events to take place, which enhances considerably the ability to assess fate of chemicals in the environment. This type of modeling is known as probability modeling.

These methodologies for assessment of fate of chemicals in soil environments will be reviewed. A general description of how they work, their strengths and their weaknesses, and examples of each will be presented.

EXAMINATION OF SELECTED NIGERIAN PLANTS FOR THEIR ANTIFEEDANT AND INSECTICIDAL ACTIVITIES AGAINST PEST INSECTS.

P. ESCOUBAS, L. LAJIDE, J. MIZUTANI. (Research Development Corporation of Japan (JRDC). Eniwa RBP, Eniwa-shi, Megumino Kita 3-1-1, Hokkaido 061-13, Japan).

As part of a global strategy for investigating new leads for pesticidal compounds in plant natural products, we have evaluated the toxic, phagodeterrent and growth-inhibitory activities of a series of selected plants from Nigeria against pest insects, including Lepidoptera, Diptera and Isoptera. Plants were collected according to their traditional use for medicinal and anti-insect properties. Among the samples tested, several displayed a significant level of activity against one or several of the test insects. Further chemical investigation of the samples, and bioassay-guided fractionation, have yielded a number of active constituents, such as kaurane-type diterpenes antifeedants from *Xylopia aethiopica* (Annonaceae), growth-inhibitory and toxic compounds from *Dichapetalum barteri* (Dichapetalaceae), *Hymenocardia acida* (Euphorbiaceae), *Vitex doniana* (Vitaceae), *Detarium microcarpum* (Leguminosae) and *Piliostigma thonningii* (Leguminosae). The results of the screening, as well as the structures of active constituents will be discussed.

EFFECTS OF PLANT LECTINS ON LARVAE OF THE SHEEP BLOWFLY *LUCILIA CUPRINA* (WIED.). C.H. Eisemann, R.L. Tellam, L.C. Cadogan, R.A. Donaldson, R.D. Pearson and T. Vuocolo (CSIRO Division of Tropical Animal Production, Long Pocket Laboratories, Meiers Road, Indooroopilly, Qld., Australia)

Lectins derived from *Triticum vulgaris* (wheat germ lectin, WGL), *Canavalia ensiformis* (concanavalin A, CA) and *Lens culinaris* (lentil lectin, LL), when fed to neonate larvae of *Lucilia cuprina* at concentrations of 0.8 - 50 μM, caused substantial slowing of growth as well as mortality of up to 100% within 24 hours. The concentrations required for a given effect were reduced 4 - 16 fold when the lectins were presented in a diet free of ovine blood serum. Inclusion of specific binding substrates for the three lectins in the serum-free diet nearly abolished the growth-retarding and mortality effects of WGL and LL, indicating that sugar-binding sites of these lectins are essential to their effects on the larvae. All three lectins exhibited significant antifeedant activity against larvae of *L. cuprina*. The lectin which most strongly affected growth and survival, WGL, was shown to bind to peritrophic membrane (PM) and membranes of midgut epithelial cells after ingestion by feeding larvae. Permeability of the PM was greatly reduced in larvae fed WGL, suggesting a mode of action in which binding of WGL to PM components restricts passage of macromolecules between endo- and ecto-peritrophic spaces.

INSECT ANTIFEEDANTAL AND INSECTICIDAL COMPOUNDS FROM PHELLODENDRON CHINENSE FRUITS. Rong-hui Su(Institute of Zoology,Academia Sinica, Beijing 100080, China), Mujo Kim(Taiyo Kagaku Co., Ltd., Mie 510, Japan), Shozo Takahashi(Pesticide Research Institute, Kyoto University, Kyoto 606, Japan)

Methanolic extracts of Phellodendron chinense fruits showed antifeedantal and insecticidal activities against Reticulitermes speratus and Musca domestica respectively. By partition with hexane, chloroform, ethyl acetate and water, both of antifeedantal and insecticidal activities were found in the hexane fraction. A disc with 1 mg of this fraction had 100% antifeedantal rate toR. speratus in a method of no choice bioassay. And a 4 mg dose showed 90% mortality to M.domestica in a dry film method. As the antifeedants, N-methylflindersine, melianone and niloticin were isolated by further separation and purification by using colum chromatograph and HPLC. N-methylflindersine showed the highest activity. Three N-isobutylamides were also isolated and were responaible for the insecticidal activity of the fruits. All structures of active compounds had been determined.

STUDIES ON THE BIOACTIVE PRINCIPLES OF TEPHROSIA VOGELII HOOK F. AGAINST PIERIS RAPEA L. Ye-guang Zhang, Shin-foon Chiu (South China Agricultural University,Guangzhou 510642 China), Qiang Zeng, Zhi-zhen Shang (Nankai University, Tianjin 300071 China).

Based on the discovery of strong activity of growth inhibitory and antifeeding properties, the studies on the principles of T. vogelii were carried out with the methods of combinating phytochemistry and bioassay. Four bioactive pure compounds have been isolated from the leaves, and their molecular structures were identified as rotenone($C_{23}H_{22}O_6$), 2,3-dehydrorotenone($C_{23}H_{20}O_6$) and two compounds of hydroxylrotenone (I,II, $C_{23}H_{22}O_7$)

The results of bioassay showed that rotenone and dehydrorotenone were active as both growth inhibition and antifeedant,against the 5th-instar larvae of P.rapae with their median antifeeding concentrations (AFC_{50}) 6.22ppm, 88.7ppm, respectively, and the median effective concentrations (EC_{50}) of growth and developmental inhibition 57.1ppm, 581.4ppm, respectively. Hydroxylrotenone I,II possessed only antifeedant activity (AFC_{50} 56.5ppm and 34.9ppm, respectively), no growth inhibition activity was found even treated with 2000ppm.

In addition, obvious differences in the contents of the insecticidal principles were discovered either among the varieties of this plant or in the different parts of a single plant.

ACARICIDAL AND REPELLENCE EFFECTS OF A PLANT EXTRACT AGAINST *R. APPENDICULATUS*. Esther N. Mwangi (P.O. Box 30772, Nairobi, Kenya)

A purified oil extracted from a local plant was tested for acaricidal and repellence properties on all instars of the tick *R. appendiculatus*. Using an *in vivo* assay, the LC50 was 0.024%. In an *in vivo* test on rabbits, a 1.0% concentration killed 100% of larvae and nymphs, and 75% of adults. The residual effect of the extract on rabbits was 4 days. Possibilities of using this product for control of ticks is discussed.

STUDIES ON AN INSECT GROWTH REGULATOR-MEIYOUNIAO RESIDE DEGRADATION IN WHEAT AND SOIL. Ben-chang Li,Xiao-hui Gao,Yu-huan Wu (Div. of Pesticide Residue Analysis, ICAMA, Beijing 100026, China)

Meiyouniao is a specific insect growth regulator, its chemical name is 1-(4-chlorophenyl) 3-(2-fluorbenzpyl) urea. It causes death of insects by inhibition of chitin synthesis and so interfering with the formation of the cuticle. It's a comparatively ideal insecticide, based on the viewpoint of environmental toxicology. It was developed in China and registerred in China in 1987. The residue degradation studies was carried out in two sites located both in Beijing and in Henan province from 1984 to 1985. The results showed that the half life is ranged from 7.5 to 8 days in wheat and 8 to 9 days in soil respectively. The residue levels are ranged from 0.16 to 1.89 ppm in wheat and less than 0. 02 to 0. 2 ppm in soil respectively when the application rate is 20 g a.i/mu, the plots are treated for 1 to 2 times and sampling intervals from application dates are ranged from 15 to 30 days.

ANTIBODIES TO CARBAMATES. Yi-liang Zeng (Department of Pesticide Chemistry and Toxicology, Institute of Zoology, Academia Sinica, Beijing 100080 China)

Competitive Enzyme-Linked immunosorbent assays were developed for carbamate insecticides on residue analysis in the environment. By the condensed or combined reactions of naphthalene or bunzofuran derivatives with aminocaboxylic acids or succinic anhydride, a library of carboxylic derivatives structurally related to the insecticides Carbaryl and Carbofuran has been synthesized, for use as haptens, which were coupled to carrier proteins BSA, OVA, CONA and KLH for immunization of several rabbits to raise antibodies, for example, both NAPH5-KLHAb 1339 and NAPH6-KLHAb 2114. Some immunizing antigens were used as the coating antigens.

Antibodies resulting from the amide-acide derivatives have a specificity for carbaryl in the ELISA. The experments demonstrated that the antibodies NAPH6-KLHAb 2114-NAPH11BSA(2nd boosting, titer 1/6400) could quantitate carbaryl upon the linear range 5-400ng/ml, with a limit of detectability of 2.5ng/ml.

ANTIFEEDANT AND GROWTH INHIBITORY EFFECTS OF TALL OIL AND DERIVATIVES AGAINST THE VARIEGATED CUTWORM, *PERIDROMA SAUCIA* HÜBNER (LEPIDOPTERA: NOCTUIDAE).

Yongshou Xie, Murray B. Isman (Department of Plant Science, University of British Columbia, Vancouver, Canada V6T 1Z4), Terry Jarvis, G.H. Neil Towers (Department of Botany, University of British Columbia, Vancouver, Canada V6T 1Z4)

The threat of conventional insecticides to the environment and to public health provides an impetus for the investigation into alternative sources for pest control products. One potential source of new insecticides is higher plants. In the present study, crude tall oil, a by-product of the kraft process for wood pulping of pine and spruce, and its derivatives, were assessed for antifeedant and growth inhibitory effects against the variegated cutworm, *Peridroma saucia* Hübner.

The materials tested are both toxic to neonate *P. saucia* and inhibitory to larval growth. These materials significantly reduced growth, feeding, and dietary utilization by first-, second-, third- and fourth-instar larvae in chronic larval growth bioassays, choice and no-choice feeding tests, and nutritional experiments. In growth studies with depitched tall oil (1.0 - 2.5% fresh wt. of diet), mean time to pupation and adult emergence were significantly lengthened with increasing concentration. Depitched tall oil significantly reduced both consumption rate and the efficiency of conversion of food (i.e. nutritional efficiency) with corresponding reduction in growth rate, suggesting that both antifeedant and toxic effects are involved in larval growth inhibition. Depitched tall oil is consistently more biologically active than crude tall oil and tall oil pitch. Our results suggest that an environmentally sound, low cost natural pest control agent may be developed based on tall oil.

Studies currently in progress are aimed at determining the role of resin acids in the bioactivity of depitched tall oil, as well as the isolation and elucidation of other insect bioactive compounds in this material. Greenhouse and field trials with depitched tall oil and derivatives thereof for the control of various pest insects are also underway.

FUTURE TRENDS IN PESTICIDE RESEARCH. Steven L. Riley, David A. Marsden, William P.N.Lau, S.H. Chang, Harry H. Harder (Du Pont China Ltd 1122, New World Office Building (East Wing) Hong Kong)

The future of the agricultural pest control business will undergo major changes throughout the next decade and beyond. A reduced number of large global companies guided by new advances in technology and aware of the various global markets will make up the future of the pest control business. The need for multidisciplinary teams for discovery research along with the increased costs for compound registration and reregistration of older materials will only be possible with large specialized staffs of scientists. Factors such as the need to feed an ever increasing world population from a decreasing base of agricultural land coupled with the increasing awareness for environmental and public health concerns will play a major part in the future development of these new pest control technologies. Areas such as chemistry, physiology/biochemistry, biological pesticides and biotechnology are examples of some of the areas that these new discoveries will emerge from and provide safer and more effective crop protection products.

PERFORMANCE OF SILAFLUOFEN - A PROMISING SILICON-CONTAINING INSECTICIDES - ON PLANTHOPPERS AND LEAFHOPPERS IN RICE. K. GUNJIMA, N. SUZUKI, and H. SCHUBERT, (Agricultural Research Center, Hoechst Japan Ltd., Chiba 289-13, Japan)

Silafluofen (Code No.: Hoe 084498) is a promising candidate insecticide in paddy rice due to its high insecticidal potency for key rice insect pests and low fish toxicity. The biological properties of this compound were determined in planthoppers (Nilaparvata lugens, Sogatella furcifera and Laodelphax striatellus) and leafhoppers (Nephotettix cincticeps) under laboratory and field conditions. Results indicate that silafluofen has excellent efficacy with unique characteristics distinct from those of conventional insecticides such as OPs, carbamates and pyrethroids. Insecticidal performance of this compound was summarized as follows.

* Potent dermal toxicity
* Paralyzing action
* Negligible level of synergism with piperonyl butoxide
* Little temperature dependence of insecticidal activity
* Excellent residual activity
* No cross resistance to OPs, carbamates

Biological properties will be discussed in detail.

EFFICACY OF CERTAIN INSECTICIDES ON SOME COTTON PESTES.

MAKRAM BASSILY ATTIA
Facultiy of Agricultural, Menoufia University
Egypt.

Tested insecticides could be classified, according to their effect on Bemisia tabaci and Nezara viridula into 3 groups. Group I included Tamaron combi 33% Ec which reduced populations by 88 and 82%, respectively.Group 2 included moderately effective insecticides; Bullduck 2.5% Ec with population reduction means 76 and 74%, respectively. Group 3 included the least effective materials, Delfos-2 Ec and dursban 48% Ec these decreased populations less than 60%.

Tested insecticides were quite hazardous for tested predators. All formulations, except for Marshal destroyed 92 - 72% of predators.

EFFECT OF PERIZIN(COUMAFOS) A SYSTEMIC ACCARICIDE USED AGAINST VARROA JACOBSONI OUD. (ACARI: VARROIDAE), ON THE LIFE OF BEE-EATERS (CORACIIFORMES:MEROPIDAE).M.S.MOSSADEGH,Department of Entomology,College of Agriculture, Shahid Chamran University Ahwaz, Iran.

Bee-eaters are known as predatory birds. In Iran and some other countries they prey importantly on Apis mellifera L. colonies. Three species of the bee-eaters, Merops apiaster L., M. superciliosus Persicus, and M. orientalis Neuman have been recorded in Iran.

In Iran since Feb. 1989. Perizin has been used extensively against Varroa jacobsoni Oud. mite in honeybee A. mellifer colonies. From Sept. 1989-Nov. 1991, effect of Perizin on the life of bee-eaters was studied. The flight activities of the birds preyed on the treated honeybees seized, 75-150 min. after the treatment, the death occured within 10-15 min. later. The number of the bees i.e., head capsules, and fore wings in the stomach contents of the disected dead birds were 1-11 with a mean of 3.63±3.48 /bird. This was 5-25 bees in collected pellets with a mean of 10.85±5.65/bird.All the birds did not die after their flight activities was seized. 23.81% of the birds resummed their flight activities again 24h. after the treatment. The number of the dead bee-eaters collected around of the treated apiaries were 4-250 with a mean of 61.43±82.14 / apiary.

EFFICACY OF AC303,630 INSECTICIDE-ACARICIDE FOR CONTROL RESISTANT ARTHROPOD PESTS. T.L.Merriam[1], J.Behm[1], R.Farlow[1], S.C.Lee[2] and T.W.Hofman[3]; American Cyanamid Company, Princeton, NJ, USA[1], Singapore[2] and Brussels, Belgium[3].

AC303,630 is a member of a new class of compounds, known as the pyrroles, which has demonstrated broad spectrum insecticidal and acaricidal activity. Results of worldwide field research conducted in 1990 and 1991 have shown AC303,630 to be effective for control of many economically important arthropods which are resistant to carbamate, organophosphate and pyrethroid insecticides. Example of pests that are resistant to conventional products, but are controlled by AC303,630 include :
Brevipalpus phoenicis, Heliothis virescens, Leptinotarsa decemlineata, Plutella xyllostella, Spodoptera littoralis, Tetranychus spp and Thrips palmi. AC303,630 is a potential candidate for use in arthropod resistance management programs.

THE USE OF HPLI EQUIPMENT FOR THE APPLICATION OF INSECTICIDES FOR CONTROL OF GRUBS AND MOLE CRICKETS. L.A. Lemke, D.H. Houseworth (Ciba-Geigy Corp., P.O. Box 18300, Greensboro, NC 27419 USA), P. Vittum (Dept. Entomology, Univ. Massachusetts, Amherst, MA 01003 USA), P. Cobb (Depart. Entomology, Auburn University, Auburn, AL USA).

HPLI (high-pressure liquid injection) equipment has been evaluated as a means to apply insecticides for control of turf insects. The material is applied at psi of 2000. The advantage of this system is its ability to penetrate through the thatch layer of the turf. It allows more material to get to the insect thus allowing for the use of at least half the labelled rate of the pesticide. In addition residues left on grass blades is significantly less than that present when conventional spray equipment is used. Control obtained with Triumph at 1 lb ai/a is in excess of an average 90% control of white grubs for all trials conducted. HPLI is also showing promise in the use for control of turf diseases.

EFFECTS OF BENZOYLPHENYLUREAS ON SEVERAL INSECT PESTS. Lei Shi, Shu-lian Lian (Institute of Plant Protection, Jilin Academy of Agricultural Sciences, Jilin Province 136100, China)

From 1984 to 1990, three benzoylphenylureas, diflubenzuron, benzoylphenylureas No. 3 (1-(4-chlorophenyl)-3-(2-chlorbenzoyl)urea) and trifluron were experimented systematically in Jilin Province, China. The laboratory experiments showed that ratio of LC50 stomach toxicity of diflubenzuron, benzoylphenylureas No. 3 and trifluron on the third instar larvae of Mythimna separata were 1:0.64:3.19. The field experiments and demonstrations showed that the mortalities of diflubenzuron at the rated of 22.5, 37.5 and 75.0(ai.)/ha. to 2-3 instar larvae of M. separata in wheat were 95.6, 94.4 and 96.9% , respectively, 7 days after treatments; the mortalities of benzoylphenylureas No. 3 at the rates of 120, 150 and 300g (ai.)/ha. were 97.4, 93.3 and 99.4% , respectively,9 days after treatments; the mortalities of trifluron at the rates fo 30.0, 75.0 and 150.0g(ai.)/ha. were 88.0, 89.8 and 85.8% , respectively, 4 days after treatments. Three chemicals were also more effective to Ostrinia furnacalis, Malacosoma neustria testacea, Hyponomeuta padellus, Pieris rapae, Mamestra brassicae and Plutella xylostella. The influence of three chemicals at the rates of recommended doses on natural emenies were negligible. such as Leis axyridis, Propylaca japonica and some mites, but caused significant mortality to Chrysopa sinica. The residual effect in the field reached 20 days, and was longer than organic phosphorus. The effects of three chemicals were not influenced by the rainfall. Three chemicals are safe to corn, soybean, rice, sorghum, millet fruit trees and vegetables.

RAPID MONITORING METHOD FOR INSECTICIDE RESISTANCE IN ADULTS OF GREENHOUSE WHITEFLY. Guo-xia Li, Bing-zong Zheng, Yun-feng Pan (Department of Plant Protection, Beijing Agricultural University, Beijing 100094, China)

According to the tentative method of testing insecticide resistance recommended by FAO, the toxicity of insecticides to the adults of greenhouse whitefly, Trialeurodes vaporariorum (Westwood), was detected in those of definite and naturally mixed ages. Results from testing toxicity of decamethrin in adults at 1,3,6,10,15,20d separately after emergence showed the gradual decrease in the toxicity in terms of LC_{50} from 123.5134 up to 282.4984 ppm with no significant difference as age of adults increased, and the average LC_{50} is 186.6263 ppm. Based on five toxicity determinations of decamethrin, values of LC_{50} for adults of naturally mixed ages were between 149.9191 and 252.3887 ppm with no significant difference, the average LC_{50} is 185.2027 ppm. The values of LC_{50} for adults between definite and naturally mixed ages in the same population did not differ significantly. In addition, although the 1st instar nymphs were more sensitive to insecticide than adults, resistance tendencies of both were consistent in different or same year, and the difference of resistance developments was very little. From above study it is concluded that the recommended monitoring method for insecticide resistance in greenhouse whitefly could be used with testing adults of naturally mixed ages in the field instead of testing raised ones of the same age or the 1st instar nymphs.

THE RESURGENCE OF COTTON APHIDS AND LEAF MITES INDUCED BY FENVALERATE. Han Lijuon, Ku Zhongyan; Wang Qiang, Huong Xionglin, Xu Xiaolong (Institute of Plant Protection, Jiangsu Academy of Agricultural Sciences, Nanjing, 210014, Chian)

The population of Aphids(Aphis gossypiella Glover) or leaf mites (Tetranychus cinnabarinus Koch) on cotton leaves may develop quickly when only one dominant species is presented. The development of population may retard when both species are existing in balance on the same niche. Fenvalerate is considered as an effective aphicide when it was first to use but fail to control the mite properly. As the aphids were diminished on the cotton leaves after applying fenvalerate the mite will built up its population within 5 days and reach to 275 per plant at 23 days. when aphids and mites are presented on the same leaf in balance the mite will develop its population after 19 days and reach to 155 per plant at 30 days. Due to the development of resistant strain of aphids to pyrethroids the condition may reversed. After the application of fenvalerate a certain portion of mite were diminished but left a great portion of aphids on the leaves. Due to destruction of the balance of aphids and mites relation the resurgence of aphids or mites outbreak became evidently.

#1

THE ANTIFEEDING AND GROWTH-DISRUPTING EFFECTS OF EXTRACTS OF *AJUGA NIPPONENSIS* (MAKIN). Chunyan Liao, Dunsong Li & Yunjun Wang (Department of Plant protection, South China Agricultural University, Guangzhou 510642, China).

Treatment with methanol and chloroform extracts of the herb *Ajuga nipponensis* showed significant bioactivity against 5th instar larvae of *Pieris rapae* L. When the extracts were applied to cabbage leaves, the concentration for 50% antifeeding activity was 0.314% and 0.121% respectively. Concentrations of 1% methanol extract and 0.5% chloroform extract produced growth inhibition in *P. rapae* of 54% and 71% respectively, which is comparable to the effect of 50 ppm dimilin. The symptoms of moulting and pupation inhibition were quite varied. The major symptoms were: (1) intermediate forms between larvae and pupae; (2) dark spots and vesiculate bulges on the cuticle; (3) the last larval instar prolonged by 3 to 6 days; (4) deformed pupae or the pupae about two-thirds of normal size. The hatching rate was dramatically decreased when second, fourth and sixth-day eggs of *Bombyx mori* were treated with 1% methanol and 0.5% chloroform extracts of *A. nipponensis*; there was almost no effect on hatching rate when the eggs were older than 6 days. The active components of the methanol and chloroform extracts of *A. nipponensis* appear to be phytoecdysones. Their deleterious effects on egg and larval stages of some Lepidoptera indicate that they may be valuable for the control of lepidopteran pests.

#2

STUDIES ON THE INSECTICIDAL ACTION OF AJUGA NIPPONESIS AND AVERMECTIN ON SOME AGRICULTURAL INSECT PESTS. Duan-ping Huang (South China Agricultural University, Guangzhou 510642, China)

In laboratory studies on the insecticidal activity of Ajuga nipponesis and avermectin against larvae of Pieris rapae, Plutella xylostella and Ostrinia furnacalis, it was shown that Avermectin acted significantly as a stomach and contact poison. Results of the test with Avermectin against larvae of P.rapae showed the LD_{50} was 0.0023μ g/larva and 0.0052μ g/larva by contact. When Avermectin was mixed with the artificical diet the feeding was considerably deterred in O. furnacalis. In topical application test, LD_{50} was 0.02μ g/larva. Avermectin was very effective against larvae of P. xylostella, as a stomach poison LD_{50} was 0.044μ g/larva. Results of pot experiments with the compound at 1 ppm gave 90 % control efficiency. Treatment with 1 % methanol extract of Ajuga against the pupae of O.furnacalis, the emergence was completely inhibited. When tested by topical application to P. rapae at 10μ g/larva, it was found to be effective in inhibiting the feeding of the insect., the rate of feeding inhibition was 24.4%. Poisoning of the lepidopterous larvae resulting from contact with Avermectin is usually a slow process. At first, the insect failed to move and feed, then became paralysed and at last slowly died out.

#3

EFFECTS OF AZADIRACHTIN ON OOCYTE DEVELOPMENT ON CHINESE RICE GRASSHOPPER AND OF NEEM SEED OIL ON THE PHASE CHANGE OF THE NYMPHS OF ORIENTAL MIGRATORY LOCUST. Xiu-qiong Liu, Mei-ying Hu and Zhi-xin Cui. (Laboratory of Insect Toxicology, South China Agricultural University, Guangzhou 510642, China)

Results of laboratory experiments with Chinese rice grasshopper (Oxya chinensis) showed that when 6th instar nymphs were fed on rice seedling sprayed with 0.5ppm and 5ppm azadirachtin, the nymphs transformed to adults, but after 20-25 days the oocytes of the treated insect was completely atrophied, whereas the oocytes from adults reared for nymphs feeding on untreated rice seedlings fully developed. It was observed that high dosage of azadirachtin (5ppm) affected the growth and antifeeding, whereas low dosage (0.5ppm) only affected oocytes development and its total weight of feces were similar to the control, thus it seems at low dosage there was no antifeeding. Results of laboratory experments with oriental migratory locust (Locusta migratoria manilensis) showed that when 4th instar nymphs were sprayed with 400, 1600 ppm AZT-VR-K, the nymphs developed to 5th instar and to adults, but the body colour external morphology and the behaviour changed. The colour of treated nymphs often developed to intermadiate and solitary phase with green, grey, or brown colour. The pronotum of the emerged adults from treated nymphs became longer and crested. The treated locusts were much less active in jumping and climbing.

#4

EFFECT OF HOST PLANTS ON THE SUSCEPTIBILITY OF THE GREEN PEACH APHID MYZUS PERSICAE (SULZER) TO BOTANICAL INSECTICIDES. Lo-en Yang (Division of Entomology, Zhongkai Agrotechnical College, Guangzhou, 510255, China)

The green peach aphid Myzus persicae (Sulzer) is a major pest on vegetables, crops and peach in China. The nymphs of the aphid were reared for two successive generations on five different hosts viz. lettuce (Lactuca sativa var.), crowndaisy chrysanthemum (Chrysanthemum coronarium var.), tobacco (Nicotiana tabacum Linn.), mustard (Brassica alboglabra Bail.) and radish (Raphanus sativus L.) for studying the effects of host plants on the susceptibility to botanical insecticides. Results of laboratory experiments showed that when sprayed with 0.39% rotenone (isolated from Derris root), the aphids fed on radish were the most tolerant to this botanical insecticides while those fed on lettuce were the most susceptible toward this insecticides. Treatment with dimethoate showed similar results. Possible mechanism for the responses to the two insecticides induced by food plant and their significances to field application rates in relation to IPM program are discussed.

#5

INSECT ANTIFEEDANT (-)-POLYGODIAL: EXTRACTION, STABILITY AND BIOACTIVITY. **Zhong-ning Zhang, Xun Liu, Zhao-xiang Lou, Hong-wen Li** (Institute of Zoology, Academia Sinica, Beijing 100080, China), **Shu-xun Zhu, Feng Zou** (Institute of Vegetable, Wuhan 430065, China), **Wei Yan** (Hangzhou Industrial College, Hangzhou 310000, China)

(-)-Polygodial was extracted from *Polygonum hydropiper L.* It possesses potent antifeedantal activity to many species of insect pests. The content of (-)-Polygodial in dried leaves was about 0.1% and in dried tender stem was about 0.01%.

The stability of synthesized (±)-Polygodial by air (room temperature), light (room temperature, N_2, 2*8w fluorescent 15cm), heat (air, 55-60°C) was tested; the half-lives were 35 days, 34 days and 16 days, respectively.

Indoor antifeedantal test showed that: crude extract (1%, 0.5% and 0.1% in alcohol) was effective against aphids as compared with water, the values of t test were 5.06, 4.12 and 1.23, respectively.

Field antifeedantal test showed that: (1) 10% emulsion of crude extraction (xylene/tween 80 1:1) was deluted to 1%, 0.5% and 0.33% by water. Using daub method (clear off aphids before test) after 7 days the average numbers of aphid were 1.2, 3.6 and 7.6, respectively against the CK (water) 75.2. Using spray method after 7 days the corrected effect were 96.3%, 90.0% and 82.7% against water; (2) 15% emulsion of curde extraction was deluted by water 600, 800 and 1000 times against aphids in cabbage caterpillar field after 5 days and the population of aphids was reduced to reach 6.7%, 21.3% and 48% of the original, respectively as compared with Decis (2.5% deluted to 2000 times) 96.0%.

#6

THE ANTIFEEDANTAL CONSTITUTIONS OF MELIA AZEDARACH L. GROWING IN CHINA. M.X.Pan; C.H. Zhou, Department of Applied Chemistry, Beijing Agricultural University, Beijing 100094, China

This is a continuation of the study on active constitutions in plants since 1985. From the fruit and root of Melia azadarach L. which is growing in China , there were isolated two new antifeedantal triterpinoids-- -Melianone , -Meliantriol. By chemicla degradation, IR, UV, MS and 2D-NMR, the structures of the two new antifeedants were to be 21,23-epoxy-21-hydroxytiucall-9-en-3-one and 21,23-epoxy-21,24,25-trihydroxytiucall-9-en-3-one. The -Melianone and -Melianotriol showed some antifeedantal effects on the third and fourth ear-cutting caterpille (Mythimna separata), cabbage worm (Pieris rapae) and locust (Locusta migriateria amnileisis).

#7
THE RESPONSES OF THE MAXILLARY SENSILLA STYLOCONICA OF THE ARMYWORM LARVAE TO SUCROSE AND THE EFFECTS OF TOOSENDANIN ON THE RESPONSES.
Pei-ai Zhou, Hou-wei Liu, Hui-wen Cheng and Lin-er Luo.
(Department of Biology, Peking University, Beijing 100871, China)

Isolated maxillae of the last instar larvae (*Mythimna separate* Walker) were used. Glass capillaries of about 30 μm tip diameter were used as stimulatory-recording electrodes. Sucrose solutions with a concentration gradient 100、50、10、1 and 0.1 mmol/L were prepared with 0.1 mol/L NaCl. The results showed that the lateral sensillum styloconica was very sensitive to sucrose. The threshold discharge was near 0.5 mmol/L, and the discharge frequency increased linearly to the logarithm of the sucrose concentration. A mixture solution of 10 mmol/L sucrose + 0.2 mmol/L toosendanin was applied to the lateral sensillum styloconica, the discharge frequency reduced to about half of 10mmol/L sucrose alone. The sensitivity of the medial sensillum styloconica to sucrose was much more lower than that of the lateral one However, there was no inhibitory effect of toosendanin on the response of the medial sensillum styloconica with the mixture solution of 10mmol/L sucrose + 0.2 mmol/L toosendanin.

#8
INSECTICIDAL SESQUITERPENOIDS OF NUT GRASS (Cyperus rotundus) AND CITRONELLA GRASS (Cymbopogon narudus) AGAINST BROWN PLANTHOPPER. Osamu Kodama, Hideki Kato, Wei-Jung Shih, Sayuri Suzuki, Katsuyuki Suzuki, Tadami Akatsuka (Faculty of Agriculture, Ibaraki University, 3998 Ami, Ibaraki 300-03, Japan), Vilai Santisopasri (Faculty of Science, Kasetsart University, Bangkok 10900, Thailand)

In our continuing search for insect control agent from botanical sources, we have found two tropical plant extracts possessing insecticidal activity against the important agricultural insect, brown planthopper, with rice seedling dipping method.

The existence of three active compounds in nut grass and one in citronella grass has been confirmed. These active compounds were purified using solvent extraction, silica gel column chromatography and preparative HPLC. One of these compounds purified from nut grass was identified as α -cyperone. Other two compounds were related to α -cyperone. α -Cyperone caused 100% mortality at a concentration of 100μg/ml. We also obtained a pesticidal sesquiterpene alcohol from citronella grass. The structure of this sesquiterpene alcohol was considered to be cadinol related compound from 2D-COSY NMR spectra.

#9
THE EFFECT OF SOME BOTANICAL INSECTICIDES ON FECUNDITY AND SURVIVORSHIP OF TRIBOLIUM CONFUSUM. Mei-ying Hu (Laboratory of Insect Toxicology, South China Agricultural University, Guangzhou 510642, China)

The effects of azadirachtin, a compound from the seeds of neem Azadirachta indica A. Juss, and the major toxic principle rhodojaponin-III from the flowers of the yellow azalea, Rhododendron molle G.Don were tested against the adults of Tribolium confusum. A dose-response relationship was established using fecundity inhibition and mortality as effective parameters. Rhodojaponin-III incroporated into the flour at dose of 50 ppm caused a mortality of 90 % and significant fecuntity inhibitory rate of 100%. Similar results were obtained on azadirachtin at a dose of 40 ppm 7 weeks after treatmet. In addition, to the larvae of confused flour beetle, treatment with 20 ppm of azadirachtin caused high mortality with remarkable growth inhibiting effect. A ethyl acetate extract of the dried flowers of R.molle and sabadilla, a commercial product from Veratrum sabadilla Retz, as well as toosendanin, atetranortriterpenoid from Melia toosendan were also tested in laboratory, and the results are discussed.

#10
STUDIES ON SOME INSECT GROWTH REGULATORS FROM NATURAL PRODUCTS. Wen-kui Chen, Shin-foon Chiu (Laboratory of Insect Toxicology, South China Agricultural University, Guangzhou 510642, China)

Some chemicals and plant allelochemicals, including botanical insecticides (extracts P_0, P_1 and P_3 of Plumbago indica, extracts F_6, F_7, and Tr-OH of Melia azedarach, extract R_1 of Tephrasia vogelii, azadirachtin, artemissi) and synthetic IGRs (Dimilin, IKI-7899) were tested against the larvae of Plutella xylostella, Ostrinia furnacalis and Mythimna separata in laboratory. Results showed that when the larvae of M.separata were treated with 50 ppm azadirachtin and dimilin, complete inhibition of pupal ecdysis and 100 % mortality occurred, when the larvae of O.furnacalis were topically treated with 100ppm azadirachtin, dimilin and R_1, abnormal larvae were obtained, when the larvae of P. xylostella were treated with 500 ppm R_1, 70 % mortality was obtained. The different histopathological changes of the fat body, the integument and the gut were studied with the light microscope in the treated larvae of P. xylostella with several chemicals and plant allelochemicals. The effects of IGR from natural products was discussed on the basis of insect neuroendocrinology.

#11
STUDIES ON THE BIOACTIVITIES AND APPLICATIONS OF A CHINESE BOTANICAL INSECTICIDE--TOOSENDANIN. Xing Zhang, Xing-lin Wang (Northwestern Agricultural University, Yangling, Shaanxi 712100, China), Shin-Foon Chiu (South-China Agricultural University, Guangzhou 510642, China)

A series of laboratory and field experiments on the bioactivity, toxicology, formulation and application of toosendanin, a triterpenoid isolated from the bark of chinaberry (*Melia toosendan* and *M. azedarach*) were conducted. The larvae of *Pieris rapae* were used as major tested insects. The results showed that toosendanin possesses strong antifeedant, systemic and stomach-toxicity as well as insect growth inhibiting properties to the insects; its mechanism of toxicology is mainly involved with the damage of the midgut tissue, thus causing the larvae to die or become abnormal pupae or adults for the lack of nutrient or interference to physiological processes, toosendanin also acts on the disruption of the transmission of nerve potentials; the technology of extracting crude products and formulation were studied in laboratory and in a pilot factory. Finally, a 15% emulsifiable concentrate and a suspension concentrate were worked out with technical crude products as their main constituents; high effectiveness was obtained in controlling *Pieris rapae* and other several lepidopterus and coleopterus insect pests infesting various crops in the field. The local availbility, safety, and compatibility with the agro-ecosystem of this botanical insecticide emphasized its ample potential in agricultural insect pest management system.

#12
INSECTICIDAL AND SYNERGISTIC COMPOUNDS ISOLATED FROM CHINESE CHIVES. Z. G. Wang (Institute of Plant Protection, Beijing, 100094 China), X. W. Gao (Beijing Agricultural University, Beijing, 100094), T. T. Liang (Consulting Scientist, BAU).

Volatile insecticidal components were found in the edible part of the Chinese chives (Allium tuberosum Rott). Those compounds were also found to be synergistic for several organophosphorus (OP) insecticides. The compounds with toxicological activities were extracted by steam distillation and purified by TLC and GLC. Four sulfur and five non-sulfur containing substances were identified using capillary GLC-mass spectrometry. Among them, dimethyl disulfide (DDS) and allyl sulfide (AS) were found to be the most effective. The DDS and AS enhanced the toxicities of OP insecticides when topically applied onto the houseflies, either simultaneously or separately. The LD_{50} decreased 3 to 4-fold with dimethoate, 2-fold with methamidophos and 6.7-fold with monocrotophos after topical application of either DDS or AS. The crude chive extract was found to be more active as a synergist, 5-fold with dimethoate and 11-fold with methamidophos. The mechanism of the synergism were studied enzymatically. Among the 7 enzymes determined in vitro, both DDS and AS strongly inhibited the mixed-function oxidases (MFO). Their inhibition activities were 50% and 33% respectively. Moderate inhibition of the activity of the acid phosphatase were also observed. However, the crude extract from chive greens showed a considerably stronger inhibition of the activity of acetylcholinesterase at 68%.

#13
ON THE EXTERNAL COATING FY-88FB AGAINST TERMITES. Jia-zhen Song, Shu-hui Zhang(Beijing Institute of Real Estate Sciences, Beijing 100021,China)

Based on a series of biological tests for screening the optimum cladding materials and insecticides, an external coating FY-88FB with excellent expellent and contact-toxic activities to termites was developed. It can be used as an overall of collored drawing paint against termites, and possesses a number of additional advantages such as waterproof function, enhancement of ornamental quality, light tolerance, and aging prevention, ect.. It is especially available to use in the rainy area in south China where the termites damage seriously.

#14
INFLUENCES OF FORMULATION AND APPLICATION TECHNOLOGY UPON PESTICIDE DEPOSITION. Yu-qin Tu (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

Biological efficacy of pesticide is generally in close relationship with effective contact (EC) and deposition rate (DR) of spray solution on target surface. EC and DR are affected and determined by formulation. environmental conditions and application technology, in which formulation plays a fundamental and important role. The main attention was focused on wettability and retentivity of spray solution on plant leaf surface in our laboratory. It was found that wettability should be adjusted to an optimum but not highest level so that a good deposition could build up. Cotton leaves are easily wetted by water, a very low concentration of dodecylbenzenesulfonate (DBS) , 50ppm, caused serious drainage which decrased DR on leaves. But on cucumber leaves at least 400ppm of DBS is necessary to wet leaf surfaces, otherwise running-off of spray drops will occur, and this also weakens DR. A fine spray with VMD around 50μm enhanced DR even under low wettability. Recovery of carbendazim from wheat ears was elevated to 20.18% by fine spray but only 7.04% by conventional coarse spray under same wettability, and only 5.31% for coarse spray and 11.5% for fine spray if wetting agent is absent.

#15
STUDY ON THE CONTROL OF THE OSIER WEEVIL (CRYPTORRHYNCHUS LAPATHI L.) BY USING BENZOYLPHENOL UREA No. 3. Jiancai Miao, Defu Chi (Northeast Forestry University, Harbin 150040, China)

From 1987 to 1990, the oil solution, flowable oil colloid and controlrelease ointment of benzoylphenol urea No. 3 which were safe, high effective and low cost were manufactured, and the spot treatment and the hole block methods were used in the controlling of osier weevil in larva and adult stage. The effect mechanisms of benzoylphenol urea No. 3 on larva and adult of this pest are also discussed in this paper. Study results showed that comparing with the larva of untreated group, more than 15 per cent chitins in the endocuticle of treated larva was reduced. The spraying of 15 per cent to 25 per cent of flowable oil colloid of benzoylphenol urea No. 3 made the ovary and the testis undevelopment, and the number of eggs laid by the treated female was reduced by 40 per cent to 70 per cent, and the hatching rate of those eggs became zero. This study showed that the oil solution, flowable oil colloid and control release ointment of Benzoylphenol urea No. 3 can be effectively used in the control both of the larva and adult of osier weevil. The manufacture of these insecticides have laid up a new way for the control of borers like osier weevil.

#16
STUDY ON THE CONTROL OF OSIER WEEVIL BY USING GRANULE OF ALUMINIUM PHOSPHIDE (ALP). Jiancai Miao, Defu Chi, (Northeast Forestry University, Harbin 150040, China), Xinglong Li, Qingyu Li, Wenfu Xia (Forestry Bureau, Lindian County, Heilongjian, China)

Osier weevil (Cryptorrhynchus lapathi L.), A wide destroyer of poplar in the world, which bores into trunks or branches is one of the domestic qurantine target. In recent years, it jeopardized artificial poplar forests rampantly in North China. From 1987 to 1988, Granule of ALP was used to fumigate larvae of osier weevil and got a great success. It was extremely effective to control the older larvae, which had bored into the xylem. The death rate of the larva treated by this insecticide is from 96% to 100%. At the same time, comparing with granule of ALP, the conventional insecticides was not effective. Using granule of ALP is simple, low cost, and has a remarkable benefit to the economy and environment. This measure should be adopted for control this kind of pest.

#17
STUDIES ON NEW FORMULATION OF A COATING INSECTICIDE. Ze-jiang Li, . Zi-zhen Dong, Bang-hua Xing, Shu-ping Bai (The Centre of Epidemic Prevention of Tianjin 300011 China) Huo Li, Fu-ling Zhang (The Fu-ling Factory Insecticide of Tianjin China)

As many household pest species have the habit of making frequent contact with certain surface, they can be controlled by brushing on windowscreen with a coating insecticide which contains the cypermethrin combined with allethrin. According to the principle of slow release techniques, the water formulation type insecticide is applied on the surface of the object. The results show that the knockdown effect in KT_{50} for Musca domestica, Culex pipiens var. pallens and Blattella germanica are 2'15", 5'18", and 7'46" respectively. So, the new formulation has a very high level of effectiveness It also displays a good residual activity for flies and mosquitoes control in such a case, it persists for 10-40 days at least. When used for controlling german cokroaches, the effect could lasts for two months. The toxicity test of this coating insecticide shows that the acute oral LD_{50} for rat is 11000mg/Kg in male, 14700mg/Kg in female. It is perfectly safe for household use. Therefore it is currently available either for commercial production or for experimental use.

#18
PREDATORS, PARASITES, PESTS AND ENDOSULFAN.
Kern, M. J., Brinkmann, E., and Geiss, J. (Hoechst AG, Biol. Research, H 872, P.O.Box 800320, D-6230 Frankfurt 80, Germany)

The requirements for pest control in IPM has set off a search for insecticides which are relatively harmless to naturally occurring beneficials but which are at the same time not incompatible with the use of biological control measures.

Endosulfan (Thiodan®) comes very close to fulfilling these requirements in crops such as cotton, coffee, soybean, vegetables or fruit. Endosulfan is currently being incorporated into a wide variety of IPM programmes.

The results of our investigations have for the first time shown why endosulfan has hardly any insecticidal effect on beneficials such as the honeybee (Apis mellifera), the ladybird (Coccinella septempunctata), the green lacewing (Chrysopa carnea) or parasitic wasps (Cephalonomia stephanoderis, Prorops nasuta), while at the same time showing a very good insecticidal effect on pests such as the tobacco budworm (Heliöthis virescens), the Mexican bean beetle (Epilachna varivestis), the coffee berry borer (Hypothenemus hampei) or the boll-weevil (Anthonomus grandis).

#19

PESTICIDE FIELD APPLICATION RATES AS A TOOL FOR EVALUATING DATA FROM ENVIRONMENTAL MONITORING STUDIES. J. Vorgetts, Jr. United States Department of Agriculture—Animal and Plant Health Inspection Service (USDA—APHIS), Hyattsville, MD 20782 U.S.A.

The mission of USDA—APHIS is to provide leadership in ensuring the health and care of animals and plants, to improve agricultural productivity and competitiveness, and to contribute to the national economy and the public health. Operations programs support livestock and crop pest control and eradication efforts in the United States and some foreign countries. Programs that require the use of pesticides are subject to rules promulgated under U. S. federal laws [i.e., Federal Insecticide Fungicide and Rodenticide Act (FIFRA), National Environmental Policy Act (NEPA; Endangered Species Act (ESA)], which establish requirements for monitoring the environmental impact and fate of pesticides. A method for fulfilling the statutory requirements of these laws is to measure pesticide residue levels in various environmental components (e.g., soil, water and vegetation). Interpretation of such data is sometimes difficult, because regulatory standards for permissible residue levels for many pesticides have not been established. One approach to the assessment of residue data, when standards are unavailable, is to estimate concentrations that are likely to result from the application rate of the active ingredient in the formulation used for control. An example of data from selected west Texas cotton fields is presented to demonstrate the utility and limitations of this method.

#20

POSIBILITY OF UREA AS ATRACTOR OF FRUIT FLY OF THE ANASTREPHA GENUS IN ARAGUA VENEZUELA. Nancy Boscán de Martínez, Ligia C. Rosales and Freddy Godoy (Centro Nacional de Investigaciones Agropecuarias, Apartado Postal 4653, El Limón. Maracay, Estado Aragua, Venezuela 2101).

In order to evaluate the effects of urea to trap fruitflies of the Anastrepha genus, two trials were done in a medlar-tree Manilkara sapota (L.) Van Noyen orchad, and one in mangoe Mangifera indica L. orchard in Maracay Aragua, Venezuela. These trials were done during twelve weeks and each theatment had four repetitions in a completely randomized desing. The McPhail traps were revised weekly, changing the attractor liquid and counting the number of fruitflies caught. In medlar-tree of Manilkara sapota one of the trials consisted of three treatments: molasses 5%, Urea 1% and Torula Yeast Borax. The best treatment was Torula Yeast Borax 5 pellet in 500 cc of water followed by urea 1% and last molasses 5%. The other trial had five treatments: Urea 5%, Urea 10%, Pineapple rind water, Venezuelan preparation of Torula and Torula Yeast Borax. The decreasing order of the eficiency atraction was: Torula Yeast Borax, Pineapple rind water, Venezuelan preparation of Torula, Urea 10% and Urea 5%. In mangoe the trial consisted of four treatments: Nulure, Venezuelan preparation of Torula, Torula Yeast Borax and Urea 20%. The decreasing order of eficiency atraction was: Torula Yeast Borax, Urea 20%, Venezuelan preparation of Torula and Nulure.

#21

EFFICACY OF CERTAIN INSECTICIDES ON SOME COTTON PESTES.

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Egypt.

Tested insecticides could be classified, according to their effect on Bemisia tabaci and Nezara viridula into 3 groups. Group I included Tamaron combi 33% Ec which reduced populations by 88 and 82%, respectively.Group 2 included moderately effective insecticides; Bullduck 2.5% Ec with population reduction means 76 and 74%, respectively. Group 3 included the least effective materials, Delfos-2 Ec and dursban 48% Ec these decreased populations less than 60%.

Tested insecticides were quite hazardous for tested predators. All formulations, except for Marshal destroyed 92 - 72% of predators.

#22

THE STUDY ON THE APPLICATION OF PYRETHRIN-LIKE PESTICIDES. Lin-xiang Wu and Huang-ying Liang, (Institute of Plant Protection, Taiyuan 030031. China)

The four pyrethrin-like pesticides, fenpropathrin, cyhalothri talstar and cyfluthrin were used against the orchare pests, Tetranychus viennensis. Carposina niponsis and Grapholistha molesta. The conclusion as follows: 1. The pyrethrin-like pesticides are better one to replace the 666 and DDT. There are many advantages sush as a wide range targets, great effectiveness, for killing pests, low toxic; litter residual, and safe for human and domestic animals; 2.The suitable time is in July and August at the mid part of Shanxi, using fenpropathrin in 4000 times solution, cyhalothrin in 3000 times and cyfluthrin in 3000 times solotion to control the fruit-borers. When the rate of fruit with pests'eggs resched 1-3%,spraying the pesticides 2-3 times can reduce 92.2-99.5% of the rate of the fruit borers, this effectiveness is much better than that of using phoxim and DDVP, 3.No harm presented on the plants by the pyrethrinlike pesticides, according to the observation result from 40 varieties of five kind of fruit trees:4.Pesticides should be taken turns or mixed with each other for avoiding the resistant of the pests and promoting the control effectiveness.

#23

ON THE APPLICATION OF SUMITHION AS A NEW GRAIN PROTECTIVE AGENT. Shuxiao Du, Jinfeng Ju, Fukun Fu, Ligou Li (Heilongjiang Provincial Grains and Oils Storage and Transportation Company, No. 77, Nanma Road, Harbin 150020, China)

Study of sumithion as a grain protective agent for using in grain storage plant is first time in our country. Before this, we have employed malathion as a protective agent for nine years. Resistance to drug of stored grain pests developed gradually. The writer used sumithion produced by Ningbo Pesticide Factory in Zhejiang Province as protective agent two summers in 1990 and 1991. The dosage is 5ppm or 10ppm. The writer employed surface spray and all grain spray to corn, wheat and compared with 10-30ppm malathion and took bin without grain protective agent as control. The results showed treatments of surface spray and all grain spray at the dosage 5ppm and 10ppm of sumithion could control insects completely and was better than that of malathion. treatment. The grain without protective agent produced 3-8 insects/kg grain. The dosage of 5ppm sumithion to control insects is not overcountry standard. It needn't check residue of sumithion. The expenses is quarter of malathion.

#24

A TEST FOR CONTROL OF MICRO-INSECT PESTS WITH NEW-MADE PESTICIDE" CEROCIDE" . Jin-juan Hao, Yuan Tang, Wan-gang Zhan, Yan-hua Lian, Gui-biao Han(Agricultural University of Shanxi, Taigu 030801, China)

Micro-insects such as scales, aphids, whiteflies and so on, which covered by a thick layer of wax on their body surface, are considered to be serious pests of economic plants in modern agriculture of China. These insects can be well prevented and controled by a new-made pesticide called Cerocide mixtured with common pesticide. Cerocide is used to dissolve the wax layer of insects, so pesticide can contact with the body, obtained wonderful result. For example we prevented Japanese wax scales in 800 mu areas of jujube-trees and persimmon-trees gardens at Lin Fen, Xian Fen Counties in 1988-1990. All treatments got a good result of average mortality 95% of death and produced economic effeciency in quantity of 3 million yuan.

#25

RESEARCH ON COMBINATION OF DELTAMETHRIN AND MALATHION CONTROL STORED GRAIN INSECTS. Guo-Liang Zhang, Yianhong Li (Grain Science Research Institute of Zhejiang Province, Hangzhou 310012, China), Da-Hong Zhang (East China Normal University, Shanghai 200062, China), Guo-Ying Yu, Xian-Ming Chen, Zhi-Gang Ge, Jiang Lin (Grain Science Research Institute of Zhejiang Province, China)

Laboratory studied on nine protectants-deltamethrin, fenvalerate, bioresmethrin, biophenothrin, permethrin, carbaryl, fenitrothion, pirimiphos methyl and malathion to Sitophilus zeamais and Rhizopertha dominica. Deltamethrin was the most activeness, especially to R. dominica. Combination of deltamethrin and malathion appeared synergism to S. zeamais. Granary test of deltamethrin 0.1 mg/kg synergic by ten times of piperonyl butoxide with malathion 15 mg/kg, their effectiveness to R. dominica and S. zeamais were equal to malathion 30 mg/kg or synergic deltamethrin 0.5 mg/kg. Synergic deltamethrin 0.2 mg/kg with malathion 15 mg/kg were equal to synergic deltamethrin 1 mg/kg, and more effect than malathion 30 mg/kg. Combination fomulation of synergic deltamethrin with malathion through field test was not deteriorated to wheat seed quality. Results of insecticides residue analysis indicated that deltamethrin distributed in wheat was same as malathion most accumulated in bran, less in flour and steamed bread. Deltamethrin residual amount in steamed bread diminished a little through steaming process. Deltameytrin residue degradation in wheat was more slower than malathion.

#26

THE TEST AND APPRAISAL OF PESTICIDE DEPOSITION DESTRIBUTION BY CONVENTIONAL SPRAYERS AND APPLICATION METHODS.Ji-lian Qi,Xi-song Shao,Ping Wu,Zhi-chao Hu (Nanjing Research Institute for Agricultural Mechanization,Ministry of Agriculture, Nanjing 210014,China)

A test of spraying imitative pesticide in the rice field has been done by using Chinese conventional pesticide applying equipments and their application methods. As well as the liquid deposition distribution proportion of the imitative pesticide has been determined in the target area. Which testing result shows as following:

At present, the conventional pesticide applying equipments used and their application methods are used in the later stage of rice growth. However the pesticide deposition on the lower part of rice plant is low , generally in 5-10% of the total application volume. Of which, the most is in the area where there is no pest haunting. On the other hand, both of the misting nozzle and long-distance spraying gun which are matched on the equipment have the same problem,that the spray volume distribution is nonuniform along the direction of spray range.Thus they are difficult to meet the requirement of pest control at the later stage of rice growth.

For the Raindrop Sprinkling method and Pouring method, the improvement of the pesticide liquid deposition proportion on the lower part of rice plant is not obvious. Their spraying quality is poor, much pesticide liquid runs off and the environment is seriously polluted. So those methods mentioned above are not better to be recommended in use anymore.

In China the variety of agricultural chemicals has been renewed from generation to generation, pesticide application is being developed to the direction of more accuracy, smaller quantity, higher concentration and targeting. Therefore, reinforcing the research on the application technique, improving the application equipment is a urgent problem to solve, so as to meet the requirement of disease and pest control at the later stage of rice growth.

#27

ANALYSIS FOR TECHNICAL PROPERTIES OF LOW VOLUME SPRAYING AND ITS APPLIED SKILL IN COTTON FIELD. Yong-long Ji (Xinyang Agricultural Experimental Station, Jiangsu Research Institute for Agricultural Science in Coastal Area, China)

This text expounds that low volume spraying is the way through dispersing high concentration of chemical liquid into drop with a diameter ranging from 100 to 150 microns and exercising spraying at a capacity of 0.13- 0.26 l/ha by the principals of hydraulic or high speed airflow or centrifugal automization etc. The main properties are shown as following:

1. Less spraying volume in application, better automization, uniform in distribution of drop, effective spraying width could reach 10 meters.
2. Low loss of drift, reduction of pollution for soil and environment. At the late stage of cotton plant,the text shows that the distribution proportion on plant is 23% higher than the one by using the way of big volume with low concentration.
3. High productivity. The efficiency increases by 15 times in comparation with hand sprayer, but its cost decreases by 30% .

At present, the methods of low volume spraying which are divided into two kinds of drifting and aimming spraying are commonly used in the local cotton field. According to the incidence of insect and its harmful feature, alternative method is flexible to be conduted. So the method of low volume spraying has a broad prospect in application.

#28

STUDIES ON THE TECHNIQUES OF APPLYING INSECTICIDES FOR THE CONTROL OF LYCHEE STINK BUG (TESSARATOMA PAPILLOSA DRURY). Jin-yu Zhang (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094,China) Shin-foon Chiu (Department of Plant Protection, South China Agricultural University, Guangzhou 510642,China)

The preliminary studies on the insecticide application techniques in lychee orchard for controlling lychee stink bug were conducted from 1988 to 1990. The results indicated that the deposit state of droplets within lychee canopy was uneven after spraying with the conventional hydraulic nozzles. The amount of deposit in the outer layer was higher than in the inner layer. The good wetting property and more retention of the insecticide on lychee leaves were achieved by adding suitable surfactants into the solution and the effect of 8 surfactants at a series of concentration on the physical-chemical properties of the spray liquids was also remarkable. The trichlorphon deposited on the surfaces of lychee leaves had strong toxicity to any phase of lychee stink bug, but resistance of the adults in autumn and winter to the insecticide was significantly higher than the adults in spring and summer and the resistant difference appeared among the various instars of the nymph too. Spraying with 0.046% trichlorphon obtained the deposit amount of the insecticide much more than the lethal dose required to kill all stages of the bug. The results showed that there is a great possibility in reducing application rate and enhancing the efficiency of insecticides for controlling the bug.

#29

AERIAL SPRAY DRIFT AND DROPLET SIZE. E.W. Huddleston, R. Sanderson, A.J. Hewitt, J.B. Ross. Department of Entomology, Plant Pathology and Weed Science. New Mexico State University. Las Cruces, NM 88003 USA.

Spray drift is a major concern in the application of pesticides by aircraft. A world-wide literature review revealed extensive variation between drift studies because of meterological changes between applications. Few papers reported the droplet size spectrum of the spray solutions being evaluated. A technique was developed to permit simultaneous spraying of two spray solutions from an aircraft with a dual spraying system. Each spray solution included a different fluorescent tracer that did not interfere with the other so that deposition of each spray solution could be measured on the same collector. Experimental error due to meterological and collector variation was reduced to the point that statistical differences between the drift potential of spray solutions could be detected at the alpha = 0.01 level. Wind tunnel studies were conducted using the Malvern laser diffraction droplet size analyser. Good correlation between the volume median diameter of the spray solution and the reduction in spray drift potential was obtained.

#30

APPLICATION OF SYSTEMIC INSECTICIDES FOR CONTROL OF COTTON APHID (APHIS GOSSYPII G.). Fa-qing Hu, Chang-yuan Fang, Xiao-cao Hao, Jing-yuan Xia (Cotton Research Institute, Chinese Academy of Agric. Sci., Anyang, Henan 455112, China)

Application of systemic insecticides to control cotton aphid at seedling stage through seed and/or soil treatments have been turned out to be the very important component in integrated cotton insect pest management systems. Several new systemic insecticides were evaluated for such a purpose during the last 10 years. The significant controlling effect was obtained with the granules of carbofuran, aldicarb and phorate applied in furrow during the sowing time at the rate (kg a.i./hectare) 0.9, 0.6-0.8 and 1.5-1.8, respectively, or with the carbofuran used for seed coating at 0.8-1.0% of the dry seed weight. The priority for such treatment was that the damage from the pest could been completely prevented with the insecticides used only once and the beneficial pests could be effectively protected/preserved providing a strong basis for integrated cotton insect pest management in the later season. Those research results have been applied in the cotton-growing area with more than 10 thousand hectares, bringing about significant economic, social and ecological benefits except for slowing down development of the pest's resistance to insecticides.

#31

RESEARCH ON ULTRA-LOW-VOLUME CONTROL OF THE PISSODES VALIDIROSTRIS GYLL. WITH BEE-3 PLANE. Lichun Wang, Guocai Zhang, Zhiying Wang (Northeast Forestry University, Harbin 150040, China)

Pissodes validirostris is an important pest of Pinus sylvesiris var. mongolica in Honghuarji, Inner Mongnlica Autonomous Region. Rate of damage was about 40% in many years, and il was sometimes above 50% . The yield and quality nf seed were seriously influenced. In view of the facts, adults of P. validirostris were controlled by aerial ultra-low -volume spray with plane Bee-3 in late May 1990. The dosage of pesticide was 160g per mu. The area of control was 375 mu. The mortality of the pest was 77.3%.

#32

TREND OF F-1 PROGENY OF MALE SPODOPTERA LITURA (FABRICIUS) SUBJECTED TO SUBSTERILIZING DOSES OF GAMMA RADIATION. S.S. Sehgal and R.K. Seth (Department of Zoology, University of Delhi, Delhi 110007, INDIA)

The present study highlights the merits of using partially sterile males over the completely sterile males in SIT. Exposure of tobacco-caterpillar moth, Spodoptera litura to partially sterilizing doses of 4-20 krad of gamma radiation induced 10-70% sterility in the males without serious effects on reproductive behaviour and fecundity. The fecundity and fertility of F-1 progeny were determined in various crosses. In F-1 self-crosses, the fecundity was reduced by 21-58% at 4-20 krad respectively. F-1 male X normal female, however, reduced the fecundity by 5-65%. The egg-hatch was adversely affected in F-1 crosses as compared with parental cross. At 4 krad, P-1 (irradiated) male in a normal mating had 10% sterility while F-1 male had 27%. It increased to 97% at 20 krad. Thus, substerilizing gamma doses induced a higher level of sterility in F-1 males than in irradiated male parent. Also, the changes in the life span, sex-ratio and mating frequency of F-1 males are examined and discussed.

#33

STUDIES ON A NEW INSECTICIDE AND ACARICIDE DAMANTONG APPLICATION. Hui-zhi Tian, Ji Shi, Jing-yuan Du, Shu-wen He, Rijin Zhao (Shenyang Chemical Tndustry Academy, Shenyang 110021, China)

Damantong was tested by normal laboratory bioassay or pot experiment against Tetranychus cinnabarinus Boisduval, Aphis laburni , Rutenbach, Trialeurodes vaporariorum, Musca domestica and Mythimna separata Walker. Adverse effect experiments of damantong were carried out on cucumber, bean, citrus etc. The results showed that damantong is very effective and long period residual effect for T. cinnabarinus control, and effective against A. laburni and T. vaporariorum as well. When increasing the rate damantong gave completely control of the Erysiphe cichoracearum damantong is safe to the crops.

The results obtained from field trials showed very good quick effect and long period, and against other pests also.

#34

CGA 183'893 : A NEW INSECT GROWTH REGULATOR PARTICULARLY SUITED FOR THE CONTROL OF FLIES

W. Häusermann, T. Friedel, J-F. Graf, E.A. Hess and H. Kristinsson
Ciba-Geigy Ltd., Animal Health Division, CRA, CH-1566 St. Aubin, Switzerland

CGA 183'893 is a substituted 5-pyrimidinecarbonitrile and represents a new class of IGR. When incorporated into the breeding substrates of flies, mosquitos and fleas it prevents like other IGRs the larvae of these species to develop into pupae or adults but at more than 10-fold lower concentrations than either cyromazine or diflubenzuron.

Since it is not only more active but also much less watersoluble CGA 183'893 offers potential advantages over cyromazine for the control of parasitic flies on livestock. For example, sheep jetted with approximately 3 liters of solution each at concentrations of 100 and 250 ppm had been protected against fly strike from diazinon resistant *Lucilia cuprina* for periods of 14 and 16 weeks although they had been exposed to as much as 550 mm of rain in this period.

By contrast cyromazine, if applied by jetting at 1000 ppm, normally gives about 12 weeks protection but only 7-8 weeks, if the sheep are exposed to more than 50 mm of rain shortly after treatment.

Like cyromazine CGA 183'893 proved so far highly active against Diptera (and Siphonaptera). Hence it looks particularly promising for the control of dipteran pests or vectors that share their larval habitats with beneficial arthropods of other orders.

#35

CGA 157'419 : A NEW ACTIVE INGREDIENT FOR A NEW APPROACH TO PROTECT CATTLE AGAINST TICKS

W. Häusermann, T. Friedel, E.A. Hess, M.B. Strong
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CGA 157'419 is a new benzoylphenylurea. Unlike other BPUs, which are substituted at the para position of the aniline moiety, CGA 157'419 is substituted at the meta position. It specifically interferes with cuticle formation in ticks but shows little activity in insects.

Essentially systemic in its action CGA 157'419 is effective against all instars of one and multihost ticks at plasma levels of 10 to 40 ppb depending on species but regardless of whether the strains are resistant to chlorinated hydrocarbons, organophosphates, carbamates, amidines and pyrethroids.

For cattle the preferred application is topical as a pour-on. The active ingredient is taken up orally by grooming and, to a lesser extent, by transdermal absorption.

Controlled trials in Australia demonstrated that plasma levels of 10 ppb were sufficient to disrupt the life cycle of *Boophilus microplus*. A single pour on application of 1 or 1.5 mg/kg kept cattle free from engorged adult ticks for 6 and 12 weeks, respectively, despite continuous exposure to infective larvae.

With CGA 157'419 long term protection against ticks can thus be achieved with small amounts of active ingredient, minimal effort and little to no environmental risk.

#36

STUDIES ON APPLYING SEVERAL INSECTICIDES TO CONTROL RHYACIONIA PINICOLANA. Lichun Wang, Guocai Zhang, Zhiying Wang (Northeast Forestry University, Harbin 150040, China)

Rhyacionia pinicolana is a main pest of Pinus sylvestris var. monglica. Larvae feed on flower, buds and second years cones. High-growth, yield of cone and quality of seed of P. sylvesiris var. mongolica are influenced by injury. In view of the above mentioned facts, the occurrence rhythm of R. pinicolana was observed carefully. According to the observation, pesticides were choosed and ways of control were studied in 1988-1989. The results showed that the control effectiveness by painting the 40% omethoate at the base of P. sylvestris var. mongolica was 66.67%.

A STUDY OF RESIDUE AND DEGRADATION OF THIODICARB IN COTTON PLANT AND SOIL. Xia Xingyun, Qiao Xiongwu. Zhu Jiusheng. Zhang Caifeng. Zhang Xueyu (Institute of Plant Protection Shanxi Aca. of Agricultural Sci. Taiyuan 030031. China).

The article described the residue and degradation of Thiodicarb in the cotton seed and soil after killing off Heliothis argmigera effectively. The GC-9A. equipped with a FPD. was used to measure the residue of Thiodicarb. The results exprees two important points:

(a) The half-time degradations of Thiodicarb in soil is 6-8 days.

(b) Seventy-five percent Thiodicarb watable powder is sprayed on the cotton at the rate of 45-90g per mu each time during the whole growth period of the cotton. If the chemical is applied 4 times and the pre-harvest interval is 14 days. The residue of Thiodicarb in cotton seed will not exceed the provisinal Limit of 0.4ppm.

EFFECTIVENESS OF TOOSENDANIN AND MIXTURE WITH FENVALERATE ON PIERIS RAPAE AND CNAPHALOCROIS MEDINALIS. Zhang-xin Huang, Yu-ping Luo (Laboratory of Entomology Toxicology, South China Agricultural University, Guangzhou, 510642, China)

Based on the result of bioassay in laboratory and the field, when toosandanin mixed with fenvalerate, the larva mortality of Pieris rapae 5 days after treatment increased. Experinent with the same admixture against the larvae of Cnaphalocrois medinalis in the field, the effectiveness of control was 83.9% 5 days after treatment.

Results of experiments showed that this admixture was more efficient than used alone. The mode of action in increasing the effectiveness was correlated with the inhibition of Mixed Function Oxidases (MFO) by toosendanin, thus increasing the antifeeding action and interferring with the growth and development of the insect.

BEHAVIOR OF PESTICIDE RESIDUE OF PHOXIM ON GREENS Yu-ling Ji, Shen-tian Wang (Central Laboratory of Nanjing Agricultural University Nanjing 210014, China)

Experiments were carried out on greens for studying the degradation kinetics of insecticide phoxim. The phoxim residues were extracted with a mixed solvent of petroleum ether : acetone=1:1, and determined by gas chromatography. Recoveries of this method were 89.6± 3.2% and sensitivity was 0.004ppm.

1. Phoxim disappeared rapidly on greens. Five days after spraying, it decreased by 99%.

2. The amount of residue(C) has exponential relation with degradation rate (λ) and interval time(T) after spraying. During the first day:

$$C_1 = C_0 \cdot e^{-\lambda_1 T_1}$$

and latter:

$$C_2 = C_{01} \cdot e^{-\lambda_2 (T_2 - 1)}$$

Experimental data showed $\lambda_1 > \lambda_2$.

3. Sunlight has a significant effect on degradation rate, correlation coefficient between sunshiny time and λ was 0.846($p < 0.05$). No such relationship was found between atmospheric temperature and λ.

4. Preharvest interval days (PID) required for phoxim to decrease to tolerance level 0.05ppm has linear relation with the does(m) applied on greens:

$PID = 1.7 + 0.09m$

TOXICITY OF ORGANOPHOSPHOUS CHEMICALS AND THEIR SAFETY IN INDUSTRIAL PRODUCTION AND USE. Chaogan Yan (Nantong Pesticide Factory, Jiangsu 226006, China)

Organophosphorous chemicals against a broad range of insects with high effectivity and rapidity have been the fast-developing pesticides in recent 30-years in China. Owing to the conerted attention in safe use, lots of accidents have been prevented in China. The author discussed toxicity of organophosphous chemicals and their safety in industrial production and use in details in this paper.

PHOTODEGRADATION OF THE INSECT GROWTH REGULATOR CHLORFLUAZURON (IKI-7899) Huanqing Dai (Wenzhou Agro-Technology Extension Center, Wenzhou 325000, China), He-xin Chen & De-fang Fan (Dept. Plant Protec. Zhejiang Agric Univ., Hangzhou 310029, China)

An attempt was made to illustrate the photochemical behavior of the novel insect growth regulator cholrfluazuron (IKI 7899). Main photo products were identified with thin layer chromatography (TLC) and gas chromatography-mass spectrometry (GC-MS) and, based on the result, the putative photochemical pathway was proposed. Furthr, photodegradation of the IGR in water solution was studied. Chlorfluazuron was readily decomposed in organic solutions or on silica gel but was stable in solid phase when exposed to ultroviolet (UV) light. 2, 6-difluorobenzamide (DFBA) and 3, 5-dichloro-4-(3-chloro-5-trifluoromethyl-2-pyridinyl) aniline (TFDCA) were characterized as two main photo products. Solvolyzed product (s) was formed in methanol solution. The IGR appeared to have undergone a formal norrish Type II (S 2) elimination at N-1-C-2 bond after UV irradiation. Chlorfluazuron was persistent in acidic buffer (pH 4) and distilled water (pH 6.5) with half-lives (T1/2) over 20 days, but was quickly hydrolyzed in alkline buffer (pH 10) with half-lives around 7.5 days at 25℃ and 8 days at 38 ℃. However, when exposed to UV light, the half life was reduced to 32 thours in water solution, thus suggested that direct photolysis might be a potential dissipation route for the IGR in environmental waters.

STUDY ON THE DEGRADATION OF PYRETHRINS IN THE ENVIRONMENT. Qiankai Liu, Guonian Zhu (Plant Protection Department, Zhejiang Agricultural University, Hangzhou 310029, China)

The study on the residues of 8 pyrethrins in 8 crops was reported in this essay. The degradation rates of the pesticides in the environment are low. No pesticides in the pulp & rice were detected. Only the husk, peel or rind on which the pesticides had been applied was polluted by the pesticides. The dosages applied of deltamethrin, alphamethrin, esfenvalerate were small that the residues of them were few & the safe intervals were short. Because of their larger areas for receiving the pesticides, the foliage vegetables had more residues than the other crops did. Light was the major factor in affecting the degradation of the pesticides. Under Lab & field conditions, the photochemical degradation rates of fenvalerate & fenpropathrin decreased with the intensity of light declining, i. e. direct light >diffused light >dark. The pesticides had small capacity of movement, largely adsorbed on the surface of soil. Fenpropathrin was degraded mainly by microorganisms.

EFFICACY OF FUMIGATION FOR BROAD BEENS INFECTED WITH BROAD BETTLES WITH PHOSTOXIN OR METHYL BROMIDE.
ZHANG JUN(Hang Zhou Animal and plant Quarantine Service) Dong Caixue,Weng Zhi-ping (Ningbo Animal and,plant Quarantine Service.Ningbo 315020,China)
Bean beetle(Bruchus rufimanus Boh.) is a serious pest affecting Broad bean seed Zhejiang Province with up to 30% of seeds being attack.

Phostoxin at the rete of 8g/m', 10g/m'and Methyl bromide at the rate of. 50g/m', 70g/m', 80g/m' were, tested against Bean beetle in Broad dean in warehouse with 25℃ and above during July to August from 1989 to 1991.

Complete kill of bean beetles in Broad bean was obtained fumating with Phostoxin 8g/m',a CT product of 960gh/m' and Methyl bromide 80g/m',a CT product of 5040gh/m'.

It is pointed out that treated with Phostoxin in different layers of Broad bean pile is preferable to treated with Methyl bromide.

STUDY ON THE CONTROL EFFECT OF 27% SASANQUA SAPONIN NICOLEINE SOLULLE AQUAE CONCENTRATE TO THE UNASPIS YANONENSIS KUWANA. Shaohai Hu (Department of Biology, Hunan Normal University, Changsha 410006, China)

This paper reported the control effect of 27% Sasanqua saponin nicoleine solulle aquae concentrate on the scale Unaspis yanonensis. This pure plant insecticide were made of Sasanqua saponin (extracted from Carnellia oleifera), Synergist and emulsifiier. The effciency of the insecticide on the Unaspis yanonensis is 93.8-97.8%, which were obtained from the investigations (made 40 days after spraying) of citrus groves experiment (fixed the tree, the position and the leaves). While the efficiency of the organic insecticide Isocarthos is 70%. Random picking the leaves with injurious insects from the crown of the citrus trees 30-40 days after spraying, checking up the leaves under microscope. The results showed that the efficiency is 82.9-93.8% . This plant insecticide also can kill other pests such as Parlatoria pergendii, Ceroplastes rubens, Panonychus citri, Aphis citricidus, Aphis gossypii, Phyllocoptruta oleivora etc. The experiments demonstrated that the insecticide is rainwashing-proof; long pharmacodynam; safaty to person and domestic animal; made pests no resistance to the insecticide. This insecticide has already gained the temporary registration of insecticide new variety from ICAMA [redacted], [redacted] China, the number is Ls 91306.

EFFECT OF DANJIAMI ON MITES AND INSECTS. **Wei Yan, Zhen-yuan Xu** (Zhejiang Institute of Technology, Hangzhou 310014, China)

Danjiami is a new organic nitrogen acaricide/insecticide. Its chemical name is N-(2,4-dimethyl phenyl)-N-methyl-formamidine hydrochloride. It is a white needle-like crystal with a melting point 163-165°C and soluble in water. We have systematically investigated the effect of Danjiami on mites and insects since 1982. The laboratory and field tests prove that Danjiami 25% water solution possesses high toxicity against citrus red mite, hawthorn spider mite, pink tea rust and sheep scab mite, ox psoroptic red wax scale, arrowhead scale, cotton aphid and cotton bollworm. Under the applied concentration, Danjiami is relatively non-toxic to men, herds, birds, bees and chinese silkworms. It is safe for natural enemies e.g. *Stethorus punctillum* Weise, *Chrysopa sinica* Tjeder, seven spotted lady beetle etc. Danjiami is a promising pesticide for comprehensive control.

VOLATILIZATION OF INSECTICIDES IN RELATION TO THEIR EFFICACY AND ENVIRONMENTAL FATE. William F. Spencer, Mark M. Cliath, Scott R. Yates (Agricultural Research Service, USDA, University of California, Riverside, CA 92521 USA.)

Volatilization is the dominant process that controls the movement of applied insecticides into the general environment and their lifetime and effectiveness within the target area. Volatilization rates of insecticides from non-adsorbing surfaces are directly proportional to their relative vapor pressures. Soil-incorporated insecticides volatilize at a greatly reduced rate dependent not only on the equilibrium distribution between the air, water, and soil matrix as related to vapor pressure, solubility, and adsorption coefficients, but also, on their rate of movement to the soil surface. Vapor pressures of pesticides are greatly decreased by their interaction with soil, mainly due to adsorption. The magnitude of the adsorption effect depends on the nature of the chemical, its concentration, the soil water content, and soil properties, such as, organic matter content. The soil water content is especially important since it affects both adsorption and movement of the pesticides. Relative volatilization of different pesticides from soil is controlled by the ratio of their vapor to solution concentrations or their Henry's law constants.

CHEMICAL PEST CONTROL - WHO NEEDS IT?
Mervyn Bengston, (Entomology Branch, Department of Primary Industries, 80 Meiers Road, Indooroopilly, Brisbane, Australia 4068.)
Robin Wilkin, (39 Denham Lane, Chalfont St Peter, Gerrards Cross, Bucks., SL9 OEP England.)

Chemical control measures are a recent development yet their use has led to great improvements in the quality of food available world-wide. It has allowed an effective international trade in key foodstuffs such as grain and also permitted the holding of buffer stocks. In some places, it is possible to limit pest damage without resort to chemical control. However, in the majority of storage situations, cost-effective pest control can only be achieved with some use of chemicals.
Further progress can be expected and there will be increased use of mixtures of pesticides as grain protectants to extend the range of pests controlled. Pesticides will be rotated to delay the development of resistance and some new compounds, especially insect growth regulators, will be introduced. Application methods will be improved by the use of undiluted concentrates and sorptive dusts will help reduce residue levels. Fumigation techniques will be enhanced by better sealing, recirculation and continuous application. In addition, developments of expert systems will allow better integration of chemical control with other methods of pest control and with storage generally.

DEVELOPMENT OF STOCK PROTECTION STRATEGIES FOR BAGGED MILLED RICE IN INDONESIA. R.J. Hodges (Natural Resources Institute, Chatham, Kent ME4 4TB, UK)

Within the framework of a collaborative project, the Natural Resources Institute (NRI) and the Indonesian National Logistics Agency (BULOG) have undertaken a technical and operational evaluation of current strategies for the stock protection of bagged milled rice. This has included investigations of sealed stacks flushed with carbon dioxide and the conventional components of stock protection, namely fumigation and insecticide spraying. A comparative cost-benefit assessment was developed as an aid to the selection of the most appropriate stock protection strategies.

The principle recommendations arising from these studies are that regular spraying of store and stack surfaces with pesticide is of little if any value, that the success of fumigation under gas-tight sheets is a crucial element in stock protection and that a rigourous planning approach coupled with break-even analysis is essential to the efficient use of the resources devoted to stock protection.

PENETRATION OF PHOSPHINE IN DEEP GRAIN BINS BY AID OF CARBON DIOXIDE. Y. Carmi and E. Shaaya (Department of Stored Products, the Volcani Center, ARO, Bet Dagan, Israel).

Two field scale trials were carried out to investigate the effect of CO_2 on the distribution of phosphine in deep grain bins. The trials were conducted in two deep vertical bins containing wheat heavily infested with 4 main stored product insects.

The bins, 26 m and 37 m tall, were fumigated with magnesium phosphide 2.2 g/m^3 and 1.5 g/m^3, respectively. Carbon dioxide 200 g/m^3 in the form of dry ice was added to the bins immediately following phosphide application. Both gases were applied to the top of the bins. A satisfactory distribution of PH_3 and CO_2 was achieved throughout the bins during the 10 day fumigation period with high levels of PH_3 recorded at the base of the bins 24 h after application. Grain samples taken from the base and the top of both bins at the completion of the fumigation period showed total insect mortality. It should be noted that towards the end of the fumigation period, the highest concentrations of PH_3 were measured in the bottom of the bins. This finding, in addition to the total insect mortality achieved at the completion of the fumigation period, suggests that lower dosages of PH_3 and CO_2 might be considered.

FUMIGATION OF PEANUT KERNEL WITH METHYL PROMIDE AND PHOSPHINE.
J.W. TURNER (Department of Primary Industries, Meiers Rd., Indooroopilly, Brisbane, Australia), Yang Shaojun (Tiajin Animal and Plant Quarantine Service, Xingang, Tanggu, Tianjin, China)
The loss of phosphine and methyl bromide was compared during the fumigation of bagged peanut kernel in shipping containers covered with gas-proof sheeting. The level of absorption of methyl bromide precluded its use as a disinfestation treatment. Phosphine was recommended as the standard treatment using an exposure period of 10 days and a CT product of 200 ghrm^{-3} at 20°C or its equivalent.

THE PROBLEM OF RESISTANCE TO PHOSPHINE OF STORED GRAIN INSECTS IN SOUTH CHINA. Quan Liang (Guangdong Institute of Cereal Science Research, Guangzhou, 510310, China)

A former survey conducted in 1974 proved that nearly all of the major species of beetles developed tolerance to phosphine.A resistant strain of Sitophilus oryzae had reached to a surprising level. Current monitoring report demonstrated that the resistant strains extended to the species of minor importance as Cryptolestes ferrugineus.

The expansive tendency of phosphine resistance was mainly resulted from long-term continueous use of phosphine generated by different measures under poor gas-tight conditions and by using inadequate techniques which caused high rate of failures of fumigation.

The author stressed the critical situation and put forward some strategic recommendations of management as: (1) the establishment of responsible monitoring units. (2) training the relevant administrators and technicians for deepening the understanding of resistance. (3) give first priority to improve the gas-tightness of fumigation. (4) advocating of combined use with climate control or other methods. (5) authorizing certain units to make strategic decisions of using forbidden if necessary.

A STUDY ON THE APPLICATION OF CHINESE MEDICINAL HERBS AS PAPER ARCHIVES NEW TYPE FUMIGANT. Li-li Chang, Yu-qing Yao (Zhengzhou Grain College, Songshan Road, Zhengzhou 450052, China)

The new type fumigant-8489 insecticide on main archives insects of Falsogastrallus sauteri Pic, Attagenus unicolor japonicus Reitter, Lasioderma serricorne Fabricius, Rhizepertha dominica Fabricius, Stegobium paniceum Linnaeus has been studied by means of toxicity, efficiency, fumigation compared of full cabinet, acute toxicity and paper character. The results show that it has the most significant poisoning action on the test insects. The killing efficiency is 100% , obviously higher than that of naphthalene ball. Acute toxicity is practically nontoxic or relatively harmless. Acute oral LD50 is 9610.12mg/kg; Acute dermal LD50 is 2000mg/kg; acute breathing LD50 is 90mg/kg. It is safe to human and it has no environmental contamination. It has no obvious influence on the white dagree and dagree of breakdown of paper archives. It is the best fumigant for archives and books.

A STUDY ON MIXED FUMIGATION OF ALUMINIUM PHOSPHIDE AND CARBON DIOXIDE FOR CONTROLLING STORED GRAIN PESTS. Yongsheng Yan, Anbang Lu (Zhengzhou Grain College, Zhengzhou 450052, Henan, China), Chengyan Zhou, Zhiwen Hu (Xin-hai Grain Warehouse, Lian Yun Gang, China.)

A Study on mixed fumigation of carbon dioxide at the concentration of 4% -15% (Volume) and aluminium phosphide with dose of 0. 6g/m^3 -4. 0g/m^3 showed that carbon dioxide is synergism of the action of phosphine against 13 species of stored grain pests (such as Cryptolestes pusillus, Tribolium onfusm.) and 7 species of major mites (such as Acarus siro L, A. Casalis Berlese). When carbon dioxide is 8% -12% (Volume), mixed fumigation with the dose of 0.18g/m^3 phosphine can effectively control insects and mites which are treated in the experiments. The wheat and paddy treated by mixed fumigation are stored safely throughout the summer season. The results of mixed fumigation also indicated that carbon dioxide accelerated the phosphine penetration into the bulk grain. The distribution of carbon dioxide and phosphine in the warehouse was uniform within 24 hours after mixed fumigation. The dose of mixed fumigation with a film of plastic on the grain reduces 50% than the common dose 3g/m^3 -5g/m^3. The costs decline 40% than the ordinary fumigation with aluminium phosphide.

CONTROL POSTHARVEST INSECT PEST OF GRAIN IN FARMER'S BARN WITH ALUMINIUM PHOSPHIDE. Quan-rong Qiu (Nantong Plant Protection Station, Nantong city, Jiangsu province,226000, China)

Grain stored in barns of farmers was severely damaged by postharvest insect pest in Jiangsu province. It was estimated that the losses were 11.93% for corn, 9.29% for barley, 6.44% for wheat, 3.35% for rice, 20.85% for redbean, 10.53% for mungbean, 7.38% for broadbean. The major insect pests were rice weevil(Sitophilus oryzae Linnaeus),angoumois grain moth(Sitotroga cerealella Olivier) and etc. We successfully tested fumigation technique special for individual farmer's barn to control postharvest insect pest in 1986. In 1988 and 1989 this technique was widely recommended and total 7.47 billion kgs grain were treated.

Major points of improvement of the technique were as following:

1. Use tablet instead of powder of aluminium phosphide which lasting the releasing of PH3, prevents flame and personnels in practice no need wear gas masks.
2. The technique is suitable to all kind air prevent containers, such as wooden cabinet, jars and etc.
3. Each tablet has standerd dosage of 3.3g aluminum phosphide which could be used to treat 250-300 kg grain, and reach a control effect around 98%.
4. Each tablet could be easily wrapped by a piece of cloth in size of 10 x 10 cm^2 and buried into dried grain in the container. Seventy-two hours after treatment the sealed container should be opened to evacuate the poison gas.

FACTORS MEDIATING FORAGING OF *Plodia interpunctella* AND THE PARASITOID *Bracon hebetor*
Michael R. Strand (Department of Entomology, University of Wisconsin, Madison, WI 53706, U. S. A.

Although numerous pest insects and natural enemies have been reported in stored grain habitats, relatively little is known about how stored product pests interact with parasitoids and predators. Controlled experiments in the laboratory and field indicated that oviposition behavior by *P. interpunctella* was influenced by food quality and the density of *P. interpunctella* larvae. Secretions associated with feeding larvae served as short range attractants to moths but food odors were more important in long range orientation by moths. Parallel studies with *B. hebetor* indicated that similar factors mediated foraging by adult females. In particular, mandibular gland secretions produced by feeding larvae served as important contact kairomones for wasp foraging. These data suggest that ongoing or past infestation of stored grain affects foraging and movement of both *P. interpunctella* and its natural enemies.

PHEROMONE TRAPPING OF *Rhyzopertha dominica* and *Prostephanus truncatus* (COLEOPTERA:BOSTRICHIDAE)
Josué Leos-Martínez. Facultad de Agronomía, UANL, Ap. Post. 358, San Nicolás de los Garza, N.L. 66450, México.

Effective and confident trapping methods are needed for stored-product insects. *R. dominica* is a major pest around the world, *P. truncatus* is becoming very important in Africa and represents a threat to the rest of the world. Therefore, several tests have been made to develop pheromonal trapping methods for these insects.

Research on *R. dominica* show that: the probe trap is effective to capture insects moving into the grain mass; the Lindgren funnel trap with a polyethylene test tube containing 25 µl of dominicalure are the best aerial trap design, dispenser and dose for detection and monitoring. The best place to install a trap inside a warehouse is near the ground, close to a wall or corner.

For *P. truncatus* it was found that: trunc-call synthesized at Texas A&M University was as effective as the trunc-call produced in England. T2 alone and T1+T2 were equally attractive, but captured 30 and 26 times more insects than T1 alone, respectively. Attractiveness of baited traps lasted 8 weeks. The Lindgren trap and a different funnel trap were the most efficient aerial designs. Flight activity was crepuscular.

SEMIOCHEMICALS AND NATURAL ENEMIES IN BIORATIONAL MANAGEMENT OF STORED-PRODUCT INSECT PESTS. W.E. Burkholder, T.W. Phillips. (USDA ARS Stored-Product Insect Research Unit, Univ. Wisconsin, Madison, WI 53706 USA)

Semiochemical-based population monitoring and use of biological control organisms have become more important for non-pesticidal management of stored-product insects. Beetle pheromones can be greatly improved by the addition of grain volatile synergists, but insects from different ecological niches respond to different suites of grain volatiles. *Sitophilus oryzae*, an internal grain feeder, responds to volatiles typical of freshly broken grain, while *Tribolium castaneum*, a secondary external feeder, responds to volatiles related to grain oils. In both cases these volatiles will synergistically increase the response of beetles to their aggregation pheromones, and they show great promise for improved use of traps for monitoring and detection. Natural enemies include parasitic Hymenoptera that affect larval and pupal stages of beetles and moths, and predacious Athocoridae that feed on eggs and young larvae of external grain pests. Host range and host preferences of natural enemies can affect management decisions control and efficacies. Laboratory studies determined that *Laelius pedatus*, a bethylid parasitoid of U.S. dermestid beetles, can effectively parasitize larvae of the exotic *Trogoderma granarium*, a quarantined pest for which many control and interception strategies are necessary. *Lariophagus distinguendus*, a pteromalid parasitoid, can attack many species of beetles, but adult conditioning studies found that wasps can be trained to prefer certain hosts over others. Adult conditioning during parasitoid mass rearing could affect control of target hosts. The commercially available anthocorid predator, *Xylocoris flavipes*, can reduce pest numbers by feeding on eggs and small larvae. Recent work on the larger *Lyctocoris campestris* found this bug can kill large larvae and thus have broader effect on pest populations.

PLANT OIL TOXICITY AND ACETYLCHOLINESTERASE INHIBITION IN SEVERAL STORED PRODUCT INSECTS. E. Shaaya, S.H. Greenberg-Levy, S. Plotkin (Department of Stored Products, The Volcani Center, Israel) and C. Sukprakarn (Stored Product Insects Research Laboratory, Department of Agriculture, Bangkok, Thailand).

The fumigant toxicity of over 40 essential oils extracted from various spices and herb plants and their major monoterpenoids were evaluated against five major stored product insects. Three groups of active materials were identified according to their activity against the test insects. A concentration of 1.5-3.0 µl/l air of the most potent compound was enough to obtain 100% mortality of the adult insects tested after 24 h exposure. Higher concentrations were needed for eggs, larvae and pupae. In vitro experiments showed a possible involvement of acetylcholinesterase in insect response to the active essential oils and their monoterpenoids.

The activity of about 20 edible oils as contact insecticides was also evaluated against a number of stored product insects. Palmkernel oil was found to be most effective against Callosobruchus sps. attacking mungbeans and chickbeans. Cotton oil was found most effective against Sitophilus sps. attacking corn and wheat. Studies on the lasting effects of the active oils for a period of over one year will also be reported.

DEVELOPMENT OF IMMUNOASSAYS FOR QUANTITATIVE INSECT DETECTION IN FOODS. G. Barrie Kitto (Department of Chemistry and Biochemistry, The University of Texas at Austin, Austin, Texas 78712, USA), Wendell Burkholder (USDA/ARS, Department of Entomology, University of Wisconsin, Madison, WI 53706, USA)

Immunoassay procedures for the detection of insects and insect remains have been developed for several types of different foods and food products. These tests, which are based on enzyme-linked immunosorbent assay (ELISA) procedures, couple excellent reproducibility with ease of use. One such assay is for use with whole grain and milled grain products. The test detects all major grain insect pests and gives a positive and linear response to larval and pupal life stages as well as adult insects. The assay is applicable to a wide variety of types of grain and milled grain products, including wheat, rice, barley, oats and corn. This test is likely to be adopted as a Federal standard in the U.S.A. A similar type of assay procedure has also been developed for the analysis of insect contamination of a broad variety of spices. The presence of insects in fruit is also of concern, both for direct marketing and for fruit import and export. An immunoassay technique will be described which permits the quantitative detection of a very broad range of fruit insect pests, particularly Tephritid species, in a wide variety of different types of fruit. Monoclonal antibody techniques are also being exploited to develop species specific assays for several beneficial insects, for use with biological control programs.

INTEGRATED PEST CONTROL STRATEGY FOR STORED GRAIN-COMBINING SURFACE TREATMENTS WITH AERATION. D.M.Armitage, P.M.Cogan and D.R.Wilkin (Central Science Laboratory, Ministry of Agriculture, Fisheries and Food, London Road, Slough, Berkshire, U.K. SL3 7HJ)

Three aerated, commercial stores of 5-10 thousand tonnes were discovered to have surface infestations of *Sitophilus granarius* in mid-winter when the grain temperature was 4-9°C. The infestations were monitored using pitfall and probe traps and catches dropped to zero after the application of Etrimfos or Pirimiphos methyl 2% dust at 50 g/sq.m.. The effect of surface treatments in cooled bins were also examined in a farm scale experiment. Six, 20 t bins of wheat, each aerated at 10 cu.m/h/t with a 20 W fan and infested with 1/kg. each of *S.granarius* and *Oryzaephilus surinamensis* and 0.5/kg. of *Cryptolestes ferrugineus* as well as the mites *Glycyphagus destructor* and *Acarus siro*. The surface of three bins were treated with 45 g/sq.m of 2% pirimiphos- methyl dust. Insect numbers, as determined by pitfall traps and probe traps at the surface, 1m and 2m, fell in all bins during the winter as temperatures fell to 5°C at a cost of 2p/t. As the bins warmed up in the Spring, numbers of *O.surinamensis* rose again in the untreated bins. In the second year, *S.granarius* reached peak numbers in the untreated bins in mid- winter. The much lower numbers of insects trapped in the treated bins, may have been attributable to migration from the untreated bins. *A.siro* and *G.destructor*, together exceeded 1500/kg. at the surface of untreated bins, but were less than 10/kg. in treated bins. In the second year *Cheyletus eruditus*, reached 200/kg.

THE MANAGEMENT OF STORED PRODUCT PESTS BY NON-CHEMICAL MEANS: AN AUSTRALIAN PERSPECTIVE. Barry C. Longstaff (CSIRO Division of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia.)

Historically, Australia has relied heavily on the use of residual chemicals, in the form of structural treatments and admixtures, to protect grain in storage and in transit. Frequently, this method is supplemented by the use of grain cooling. Other methods, such as fumigation and and controlled atmospheres, have been used when this method of control has broken down or where the storage structure has been modified to permit their long-term use. With the development of insect and consumer resistance to insecticides, there are pest-management and economic incentives to increase the emphasis on these alternative non-residual or non-chemical measures. This paper reviews the range of techniques currently in use in Australia, including controlled atmospheres, the heating or cooling of grain, the use of inert dusts, and hygiene. A number of other techniques are also discussed. These are being investigated as possible candidates for use in the future. They include biological control, percussion, and the use of magnetic fields.

MALE AND FEMALE SEX PHEROMONE SYSTEMS IN ACARID MITES. Y. Kuwahara, M. Sato, S. Matsuyama, T. Suzuki (Institute of Applied Biochemistry, University of Tsukuba, Tsukuba, Ibaraki 305, JAPAN)

β-Acaridial(2(E)-(4-methyl-3-pentenylidene)-butanedial) and 2-hydroxy- 6-methylbenzaldehyde(2,6-HMBD) are known as male-excitant sex pheromones in Caloglyphus polyphyllae and Aleuroglyphus ovatus, respectively; whereas a large amount of these compounds are also present not only in females but also in males. Studies of mating behavior have suggested the presence of male-produced female attractant pheromones. Therefore, both pheromones of Acarus immobilis were studied to explain those facts rationally.

Major components found in A. immobilis consisted of a mixture of tridecane (60.8% in a hydrocarbon(HC) fraction of all stages and sexes), rosefuran, 2,6-HMBD, along with minor HCs(pentadecane(5.7%), heptadecane(1.7%), (Z)-9-heptadecene(6.8%), (Z,Z)-6,9-heptadecadiene(13.5%), pentacosane(1.6%), heptacosane(6.3%), and nonacosane(3.5%)). The male-excitant sex pheromone was identified as 2,6-HMBD (active at 10 - 100ng, while no activity was detected against females. On the other hand, female response to the male extract was confirmed, and the active fraction was concluded as a mixture of HCs mentioned above (active at 100ng). Although pentadecane, and satd. and unsated. heptadecane were specific to males, none of those were separately active.

As a result, two pheromones of A. immobilis responsible for males and females, respectively, were chemically concluded. Gregariousness is a common phenomenon of astigmatid mites, possibly triggered by male-excitant pheromones, and excited males may then emit female-attractant pheromones to lure females to mate. Therefore, sexual communication among those mites may be composed of two types of pheromones: 1) male-excitant pheromone, emitted by both sexes and only males responsive, and 2) female-attractant pheromone, present in males and only active against females.

IMPACT OF JHA'S ON AMINOACIDEMIA IN THE HAEMOLYMPH OF STORED PRODUCT PEST *CORCYRA CEPHALONICA* STATION (LEPIDOPTERA: PYRALIDAE). S. Vijayalakshmi and Panjaly Ramaraj (Zoological Research Laboratory, Thiagarajar College, Madurai, 625 009, Tamilnadu, India).

Corcyra cephalonica is a serious lepidopteran pest of stored cereals, oil seeds, and processed food etc. Present investigation deals with impact of JHA'S (Hydroprene and Methoprene) on total free amino acid level in the haemolymph of *C. cephalonica*. The normal dietary medium (Pearl millet grain) mixed with different concentrations of JHA'S (0.001 and 0.002 µl of hydroprene and methoprene separately). In course of investigation both the JHA'S significantly ($P<0.001$) caused a greater percentage reduction in total free amino acid of haemolymph at highest concentration 0.002 µl (Hydroprene: 73.44% and methoprene: 93.50%). A decline in the total free amino acid contents indicated that treatment of JH analogues affect the larval bio-chemistry of this pest and its efficient hormonal control.

AN INVESTIGATION ON THE EFFECT OF GAMMA IRRADIATION ON THE DIFFERENT DEVELOPMENTAL STAGES OF ANGUMOIS GRAIN MOTH *SITOTROGA CEREALELLA*. Hamid Reza Zolfagharieh (Atomic Energy Organization, Nuclear Research Center For Agriculture and Medical, P.O. Box 31585-4395 Karadj, Iran)

Damage caused annualy by pests of stored products in Iran is estimated to be about ten percent. In this investigation defferent doses of gamma radiation (40-1500 GY) are applied on different developmental stages. The result after statistical analysis are as follows:

Doses		Stage of age per days (GY)			
		1	2	3	4
Egg =	Lethal	50	120	350	1500
	Sterile	40	90	120	130
		Stage age per weeks (GY)			
		1	2	3	
Larva =	Lethal	1000	2000	2500	
	Sterile	200	400	500	
		Stage age per days			
		4	8		
Pupa =	Lethal	550	750		
	Sterile	250	350		
		Stage age per days			
		1			
Adult =	Lethal	1500			
	Sterile	550			

Results: (1) investigation in this project show that for destroying all stages of this insect the lethal dose is 1500GY and the sterile dose is 550GY. (2) It is not any change between quantity of protein, gluten.....between 350-1500GY doses. (3) Above 350-1500GY a decrease of 84-52 percent of germination were observed.

RADIATION DISINFESTATION OF STORED PRODUCTS. Stanisław Ignatowicz /Agricultural University of Warsaw, Department of Applied Entomology, ul. Nowoursynowska 166, 02-766 Warszawa, Poland/

The purpose of this paper is to present information for the use of ionizing radiation in treating agricultural products to disinfest them of mites and insects.

Agricultural commodities may be handled as bulk products or may be packed in containers such as bags or carton boxes. Such packaging should be done prior to irradiation. Packaging materials that cannot be penetrated by insects and mites are suggested. Two methods using ionizing radiation have been proposed for controlling stored product pests: /a/ irradiation of the infested products with high levels of radiation to kill the pests, and /b/ irradiation of the product with lower doses to produce sterility in insects and mites. The second method seems preferable, because the use of high doses of ionizing radiation requires more shielding and therefore is more expensive. The ionizing radiation which may be employed in irradiating infested products is limited to gamma rays from the radionuclides Co-60 or Cs-137, X-rays and electrons generated from machine sources operated at or below an energy level of 5 MeV or 10 MeV, respectively.

NON-CHEMICAL MANAGEMENT OF TROGODERMA GRANARIUM (EVERTS) IN STORED SORGHUM. V.J. Shivankar, A.A. Khan, S.N. Singh (Division of Seed Technology, Indian Grassland & Fodder Research Institute, Jhansi-284003, U.P., India)

Ether extracts of Acorus calamus rhizomes and Croton tiglium seeds at 1.5 g and Nerium odorus roots at 2.5 g/kg seed stored in sealed polyethylene bags at 25 ± 2°C offered safe storage with negligible seed damage (< 6%) by Trogoderma, retaining higher seed germinability (> 75%) at the end of 12 months of storage and were at par with malathion (0.08 ml/kg). Other botanicals viz. extracts of kernels of Melia azadirachta seeds of Pongamia glabra, Annona squamosa and Embelia ribes, leaves of Datura alba and Artemisia vulgaris and Plumbago zeylanica, although were inferior to former three botanicals with seed damage and germinability ranging from 8.6 - 31.3% and 54.7-70.2% respectively, after 12 months of storage, but were far superior to the untreated check, where increased seed moisture (upto 13.5%) was recorded during July-December under ambient conditions favouring insect population that resulted in about 87% germination loss mainly due to higher seed damage (82-90%) by T. granarium. The treatments with botanicals not only restricted oviposition by T. granarium but also checked adult emergence and deterred larvae of the test insect from persistent feeding on the seed of sorghum (10.5% initial moisture content and 94% pre-storage germinability).

Comparison of Biological Control Projects for Grain Pests.
Vera A. Krischik (Institute of Ecosystem Studies, Millbrook, New York 12545, USA).

A review of existing biological control projects of grain pests performed in the laboratory and field is presented. The biology of the biological control agents are given. The most important components for an effective management program is developed. Factors such as species biology, temperature, moisture, release numbers, augmentation regimes, and estimation of equilibrium population size is discussed. Comparison of biological control in grain with forest, orchard, and agricultural systems is done to ascertain the feasibility and economic effects of biological control in grain.

POPULATION REGULATION MECHANISMS IN TRIBOLIUM FREEMANI HINTON (COLEOPTERA: TENEBRIONIDAE)
Osamu Imura (National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki 305, Japan)

Tribolium freemani Hinton was discovered in imported grain in Japan and found to be a potential pest of stored products. According to a Chinese entomologist, this beetle is widely distributed in Sinkiang, China. Laboratory populations of T. freemani maintained a fairly low and stable equilibrium population. The beetle had several traits which reduced their development and population growth: pupation was markedly retarded under crowded conditions; egg production was significantly reduced in even a slightly conditioned medium; and larvae and adults voraciously predated eggs, pupae and callow adults. Although T. castaneum and T. confusum, serious pests of stored products, have similar traits, a combination of these traits which were more intensified in T. freemani than in T. castaneum and T. confusum made the population dynamics of the former species very different from those of the latter two.

EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY ON THE DEVELOPMENT OF *SITOPHILUS GRANARIUS* (L.) (COLEOPTERA: CURCULIONIDAE).
I. I. Ismali, M. A. Eweiss (Dept. of Econ. Entom. Fac. of Agric., Cairo Univ., Egypt), Soheir R. souka and Mai S. El-Degwy (Nat. Cent. Red. Res. and Tech., Egypt).

The effect of different temperatures (20, 25, 30 and 35°C)at 65±5% R.H and different relative humidities (50, 60, 70 and 80%) at 28±2°C on some biological aspects of *S. granarius* (L.) have been studied. These include the incubation period larval period, pupal period, longevity of adults and egg production. The present results revealed that the developmental stages of the insect are more affected by temperature than by relative humidity.

THE FINDINGS REPORT ON THE STORED GRAIN INSECT SPECIES AND DISTRIBUTION SITUATION OF HUNAN PROVINCE.
Shou-ming Nie. Ji-wu Zhan (The Hunan Grain Academy. Changsha 410002. China)

We found that the whole province's 224 species of stored grain insects (including spider and acarid) respectively belong in two classes. 14 orders and 64 families. By checking the home and abroad documents and materials. 95 ones of the 224 species were recorded for the first time in Hunan. 17. first in our country. 4 species of natural enimies were discovered domestically for the first time. In Hunan. ten maim stored grain destructive insects whose distrubution frequency is the highest successively are cornweevil. lesser grain borer. rest-red flour beetle. angoumois grain moth. rust-red flat grain beetle. saw-toothed grain beetle.flat grain beetle. black fungus beetle. Chinese weevil and cadelle.

Investigated the 77 grain distribution stations. 562 test and experiments areas. we got these mathematical statistics: 1. the average rate of the insects erosion of the whole province is 1.47% . the average rate of the insects consuming is 0.39% . 2. When the occurring frequency of destructive insects increased with geometrical progression, the percentage of number of destructive insects species decreases rapidly by Poisson distrubution law. 3. The occurring frequency of corn weevil and lesser grain borer is more significant on the lakeland thanin mountain area or hilly land. 4. The occurring frequency of lesser grain borer and saw-toothed grain beetle. and that of saw-toothed grain beeetle and rust-red flat grain beetle are all in positive correlation. and that of rust-red flour beetle and rust-red flat grain beetle is in high positive correlation

COMPETITION BETWEEN THE COWPEA WEEVILS Callosobruchus maculatus (F.) AND C. rhodesianus (Pic).
D P Giga, Department of Crop Science, University of Zimbabwe, P O Box MP167, Harare.

Interspecies competition between the bruchid beetles Callosobruchus maculatus (F.) and C. rhodesianus (Pic) was investigated at different temperatures. Experiments were designed as a replacement series to predict the outcome of competition after a single generation under different environmental conditions. The classical Lotka-Volterra competition model was fitted and the intrinsic rates of increase, carrying capacities and competition coefficients estimated for both species under the different conditions. The model predicted that C. maculatus is the "stronger" competitor at 25°C and 30°C but fared poorly at 20°C. C. rhodesianus is well adapted at cooler temperatures and was a "stronger" competitor at 20°C.

STUDY ON THE REGULARITY OF INSECT DISTRIBUTION IN BULK PADDY
Wang Ya-Nan, Fu Shi-Yong, Wei Shi-Ming (Sichuan Province Grain Bureau, No67. Shang Dong-Da Str, Cheng Du 610016, China)

A new monitor of insect, model GJ89-I-I, was used for studing regularity of insect distribution in unfumigation bulk paddy. It was arranged 20 groups evenly in whole store, every group was divided in 4 stages (Surface-50cm, 50-100cm, 100-150cm, 150-200cm),and 3 Periods (24, 48, 72hr). It is clear: 1). Xylocoris sp is superiority strain in numbers; Mite and *Liposcelis* bostry are Secon-dary. Simultaneously there are following property beteen mite, *Liposcelis bostrychophilus* and *Xylocoris* sp. 2).*Sitophlus zeamais* distributed mainly in Surface and bottom stage, *Liposcelis bostrychophilus* and mite distrbuted in bottom mainly, but *Xylocoris* sp. distrbuted in middle and bottom. 3).The numbers of *Liposcelis bostrychophilus* and mite decreased rapidly followed periods of increasing inspect. 4).The stability of surface and up stage is less than one of middle and bottom in bulk paddy. 5).Five strains of insect distrbuted collectly, But It is very different between strains of insect, Volue I of *Xylocoris* sp. is 25.06, Volue I of mite is 0.33 only. 6).The difference of every stage distrbution of strain of *Sitophilus zeamais* is not obvious in same period. But in different periods The difference is better, specially obviousness of 24 hr and 72hr is quit well.

A STUDY ON THE BIONOMICS AND THE INTERACTION OF THE PRINCIPAL INSECT PESTS IN TOBACCO LEAF STOREHOUSE. Xin-wun Gong, Guo-ling Meng (Department of Plant Protection, Hubei Agricultural College, Jiangling 434103, Hubei, China)

Ephestia clutella (Hubner), Lasioderma serricorne Fabricius and Tenebroides mauritanicus (L.) are the principal insect pests in tobacco leaf storehouse. According to the observation in the Laifeng Cigarette Plant from 1985 to 1988, we discover: (1) The species whose population is large at start has a large advantage in interspecific competition. (2) Each species has its preference to the tobacco leaf's nourish elements. Ephestia clutella (Hubner) has very strong taxis to the tobacco leaves containing more protein and more sugar. (3) They have different reproductive characteristics. Lasioderma serricorne Fabricius reproduce three generations in a year, and its egg-laying quantity, living ability, reproductive rate are the highest. (4) The water in tobacco leaves has some impact on the three species. When it is over 10%, it is advantageous to Ephestia clutella (Hubner), and when below 10%, it is beneficial to Lasioderma serricorne Fabricius. (5) Besides the damage to tobacco leaves, Tenebroides mauritanicus (L.) can also feed on the eggs and larva of the other two species, so it has certain control over to them.

A STUDY ON THE CHANGE DYNAMICS OF TEMPERATURES AND STORED GRAIN INSECT POPULATIONS IN SIMULATED GRAIN MASS. Guang-can Li, Xin-wei Hou, Zong-lin Qin, Qomg-cun Zhang (Chengdu Grain Storage Research Institute, Ministry of Commerce, Chengdu 610031, China)

The three temperature relations and the population dynamics of stored grain insects were simulated by a simulation trail in a groups of metat piles based on the laboratory experiment. The results showed that three temperature relations in the simulating conditions is very identical to field storage conditions. With high population densities, insect actions have some influence to the grain temperature, Hyzopertha dominica in particular has much more influence in temperature raise than Sitophilus zeamais etc. For insect density, the surface layer are much higher than other layers in the piles, the order is: surface>top>middle> bottom, the highest densities are over 10000 heads/kg, but their growth curves appears "S" sharp. When single population, Sitophilus zeamais grows faster than Hyzopertha dominica and Tribolium confusum, but while the grain temperature is higher, Hyzopertha dominica grows faster than others. If several populations with same eating habits live together, there is only one priority species in them.

MITE PROBLEMS IN STORAGE AND CONTROL TECHNIQUES UNDER IRANIAN CONDITIONS. N. Shayesteh & A. A. Pourmirza (Dept. of Entomology, University of Urmia, P.O. Box 165, Urmia 57135, Iran).

More than five hundred species of mites have been collected from various parts of Iran. The distribution and habitat have been recorded for all species. Under Iranian conditions the most important and destructive mites belongs to Tetranychidae, Eruphidae, Phytoseidae, Rhizoglyphidae, Lardoglyphidae, Glycyphagidae, Chortoglyphidae and Carpoglyphidae. Out of more than five hundred species of mites, ten of them are mainly involved in damaging stored products and man sanitation problems. Under Iranian conditions some mites control techniques, viz. inert dust application, heat treatment, cold treatment, using of atomic energy, fumigation and surface treatment have been employed to control their activities. On the whole, damages by mites is significant and in any rural area due to insufficient practices of preservation of stored products and over looked their activities losses are noticeable.

USE OF MODIFIED FLOTATION TECHNIQUE FOR ACCURATE AND QUICK DETERMINATION OF MITES IN FOOD, FEEDSTUFFS AND HOUSEDUST. B. B. Thind (Central Science Laboratory, Ministry of Agriculture, Fisheries & Food, London Road, Slough, Berkshire, SL3 7HJ, Great Britain)

Modifications are described to a previously published technique, in which kerosene is used, in a specially designed flotation flask, to separate extraneous material. Mites, as well as insects and their fragments were separated from the vegetable material by the overflow of kerosene onto a filter paper. The modifications considerably restricted deposits of unwanted debris enabling easier and rapid assessment of mites on the filter paper. Trials with a variety of samples seeded with known numbers of mites gave a mean recovery of 85% and above. Advantages inherent in the operation of this technique are, a considerable reduction in the time required to complete an extraction and the ability to separate extraneous material from a range of products with only minor adaptation to the general method. The extraction process provides undamaged mites suitable for microscopic examination. A new process of suspending extracted mites in a mixture of ethanol 46% and glycerol 54% was incorporated to allow rapid and more precise estimates of mite populations in heavily infested samples.

THE INFLUENCE OF EXPOSURE TIME TO *BACILLUS THURINGIENSIS* BERLINER ON THE SURVIVAL OF *HELIOTHIS ARMIGERA* LARVAE. Ali Asghr Pourmirza (Department of Entomology, Urmia University, Urmia, Iran)

To study the effect of exposure time and assay period on mortality and possibility of recovery after feeding of an inhibitory dosage of *Bacillus thuringiensis* (Bt), fourth instar larvae of *Heliothis armigera* were subjected to diet incorporation assays. At all dosages cumulative mortality increased until day 7 of the assays. Recovery rate was higher when larvae were fed either on low dosage or short period. However feeding cessation and subsequent death without any recovery occurred at higher dosage within 2 days. The implications of recovery in control of the larvae and the possibility of utilizing high dosages are discussed. This paper is a part of Ph.D. thesis from U.K. in 1989.

ON THE BIONOMICS AND CONTROL OF THE EXPERIMENTAL POPULATION OF MOLD MITE. Jian Yan, Long-shu Li, Wen-bing Zhu, Ke-xing Bi (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716 , China)

The morphology, biology, behavior and bionomics of mold mite Tyrophagus putrescentiae (Schrank), an important mite pest damaged seriously to stored products causing quantitative and qualitative losses and pollution problems, especially the relationships among its population dynamics, temperature, humidity, food source, and inter- and intra-species competitions were studied. A number of corresponding mathematical models were developed. The optimum conditions for its development were determined as 26°C, 85% RH and feeding on whole wheat powder. The alternate temperature and humidity are also favorable for its development. In Chongqing Region, there are two occurrence peaks in April-June and September-November of this mite in whole year. The toxicology of several aromatic vegetable oils and their mixtures to this mite pest were tested.

ECOLOGICAL STUDIES OF HOUSE DUST MITES IN JAPAN. M. Takaoka (Saitama Institute of Public Health, Saitama 338, Japan)

House dust mites are known as one of the important causative agents of allergic diseases in Japan.About 50-90% of asthmatic patients sensitively react to house dust mite extract.The most dermatitis caused by insect bite occurs in Japanese houses are considered to be caused by a Cheyletid mite, Chelacaropsis moorei. So, recently, such mites troubles in Japanese houses are gradually increasing.

Our studies on house dust mite are followings.

1) Mite fauna in house dust collected from the residence of asthmatic children and atopic dermatisis
2) Distribution of the house dust mites in Japanese houses
3) Distribution of the house dust mites in Japan
4) Seasonal occurences of house dust mites
5) Transition of mite popuration in house dust of Japan
6) Relationship between mite fauna and house conditions
7) Relationship between house dust mite and the age of house

Mites commonly found in house dust are Pyroglyphidae,Acaridae, Glycyphagidae, Tarsonemidae, Cheyletidae, Phytoseiidae,Ascidae, Haplochthomidae and Cosmochthomidae. The Pyroglyphid mites, Dermatophagoides pteronyssinus and D.farinae, were found in adundance in house dust of Japan. But the mite fauna and population were shown to change under various conditions; as determined dwelling environments, and life styles, etc.

These studies have confirmed the importance of the house dust mite in allergic diseases and have shown that absolute numbers of mites in the dust plays on important role in the sensitizaton of allergic patients.

PROGRESS IN RESEARCH OF INSECTS AND MITES INFESTING STORED FOODSTUFFS. Lung-Shu Li (Department of Plant Protection, Southwest Agricultural University Chongqing, Sichuan 630716, China)

The research on stored product insects and mites, of both fundamental study and applied techniques, have been made by the stored product pests laboratory of Southwest Agricultural University over the past 40 years.

The fauna of stored product insects and mites in Sichuan and some other provinces, some of the investigations in cooperation with several stored product units in China, were rather clear. The distribution and biology of several quarantine insects, *Sitophilus granarius, Zabrotes subfasciatus, Gnorimoschema operculella* were studied in detail. The taxonomy of food mites and relevant taxa of mites found in stored products were also studied.

The ecological study on stored product insects and mites has been done over years, including the population ecology of main stored product insects and mites, and their relationship with controlled atmosphere; the insect community ecology and the system ecology of grain piles. Since 1986, the laboratory, in cooperation with Sichuan Grain Storage Institute of the Ministry of Commerce, P.R.China, has been investigating the population dynamics of main stored product insects and developing computer predictions of their poulation growth.

The laboratory has also carried out the research on natural insecticides from plants and Co^{60} r-ray irradiation for the stored product pests.

REPRODUCTIVE DIAPAUSE OF BRUCHIDS AND ITS IMPORTANCE ON THEIR LIFE HISTORY - J. Huignard, IBEAS, Université de Tours, Parc Grandmont, 37200 Tours France.

Some species of Coleoptera Bruchidae are in reproductive diapause when the pods of their host plants are not available in nature. Induction and termination of this reproductive diapause are examined in a tropical and in a temperate species of bruchids in this paper. *Bruchidius atrolineatus* is a tropical species developing in the cowpea seeds (*Vigna unguiculata*). This insect is in reproductive diapause during the dry season and the beginning of the rainy season. This diapause is induced during the post embryonic development and depends on the photo and thermoperiodic conditions prevailing during this period. Interindividual sensitivity differences are observed in each climatic condition. Selections of strains with a low diapause incidence show that these differences are genetically determined. Interactions between short days, high humidity and the contact with the inflorescences of the host plant are necessary for the female's diapause termination. The presence of this biocenotic factor is not necessary for male diapause termination. *Bruchus rufimanus* is a univoltin species, developing in *Vicia faba* seeds in temperate countries. In this species the winter reproductive diapause is obligatory. Experiments in the fields and in laboratory show that diapause terminates when females are exposed to long days and consume the pollen of their host plant. Long days can alone terminate the reproductive diapause of a high proportion of males. In both species whatever their origin zone the regulation of the reproduction by information from the host plant allows a precise synchronization between the reproductive cycle of plant and phytophagous insect.

EVOLUTION OF BRUCHID PESTS. Peter F Credland, Department of Biology, Royal Holloway & Bedford New College, University of London, Egham Hill, Egham, Surrey TW20 0EX, U.K.

There are about 1300 known species of bruchid, or seed, beetle, the majority of which feed internally on the seeds of Leguminosae. Most are apparently monophagous. About 20 species are recognized as pests of legume seeds stored for future human or animal consumption and the most important can infest more than one species of host.

In this paper I propose to consider, in brief, the answers to three questions in the context of the evolution of bruchid pests

- What has restricted the number of species which have become pests?
  Are there characteristics peculiar to pest species?
  Is there recognizable (and important) intraspecific variation within pest species?

Finally, I wish to consider the importance of these issues to those concerned with the control of bruchid pests in the field or store, and suggest how their recognition can contribute to the solution of practical problems.

ASPECTS OF OVIPOSITION BEHAVIOUR AND STRATEGIES IN A NIGERIAN STRAIN OF CALLOSOBRUCHUS MACULATUS (FAB.) (COLEOPTERA: BRUCHIDAE). Ofuya, Thomas I. (The Federal University of Technology, P.M.B. 704, Akure, Nigeria)

Realized fecundity, egg dispersion and stratification of egg distribution in a Nigerian strain of Callosobruchus maculatus (F.) were investigated under ambient laboratory conditions. Realized fecundity in unfed females averaged 87.6 eggs. Fecundity was not influenced by seed population and competition as larva. Egg dispersion was biased towards overdispersion. Ability to overdisperse eggs decreased with increasing seed population. The stratification of egg distribution on fresh seeds arranged in concentric circles in differently sized Petri plates showed preferential oviposition from outwards, inwards. There were also differences in stratification of egg distribution on fresh seeds in differently aligned test tubes during oviposition. The results are discussed in relation to observations on oviposition behaviour and strategies in C. maculatus reported by earlier workers.

MEASURING THE BIOTYPES OF Callosobruchus maculatus. R. Mitchell (Dept. of Zoology, Ohio State University, Columbus, OH 43210), P. F. Credland (Dept of Biology, Royal Holloway & New Bedford College, Egham, Surrey TW20 0EX, England), and K. Fujii (Inst. Biological Sciences, University of Tsukuba, Tsukuba, Ibaraki, 305, Japan).

Comparisons of the biotypes of the insect require a standard methodology that eliminates the variables known to produce secondary responses by the beetles. A protocol was developed to eliminate the effect of larval competition, provide a surplus of oviposition sites, and standardize host qualities in a constant environment. The results validate the protocol as a standard way to measure the key traits that vary from biotype to biotype. Laboratory strains may respond to culture regimens by increasing fecundities to almost 120. As a rule fecundities are stable around 70-80 eggs. Dispersion of eggs is fairly constant within a biotypes but differs widely among biotypes. Similarly larval patterns of larval competition differ among biotypes.

THE PROCESS OF DOMESTICATION OF WILD BRUCHIDS: FIELD, EXPERIMENTAL, AND MODEL STUDIES. Shimada, M., Department of Biology, University of Tokyo, Komaba, Meguro-ku, Tokyo 153, Japan

I discuss the process of domestication of wild bruchids based on my following three studies.

(1)Unique life histories of a wild bruchid *Kytorhinus sharpianus*: *K. sharpianus* infests seeds of a wild legume, *Sophola flavescens*. It is partially trivoltine in nature, and infests both fresh, soft seeds and dry, matured ones. Larvae can develop in a commercial bean, *Vigna radiata*, but the larval diapause in *K. sharpianus* under a short day length may be an obstacle to invade the storage.

(2)Comparison of survival and fertility schedules between a wild and a laboratory strains of *Callosobruchus chinensis*: A wild strain had a smaller body size but lived longer with feeding. Without feeding, however, the laboratory strain lived longer and laid more eggs in young stages.

(3)Experimental and theoretical studies comparing population processes between wild and laboratory strains in *C. chinensis*: A great differences were seen in the egg-laying process. The laboratory strain controlled the number of eggs laid on beans and showed a higher hatchability at a high adult density than wild strains.

INTRASPECIFIC COMPETITION IN BRUCHIDS WITH DIFFERENT STRATEGIES. Yukiniko Toquenaga (Institute of Biological Sciences, University of Tsukuba, Tsukuba, Japan)

Callosobruchus maculatus (Coleoptera: Bruchidae) is a well-known pest bruchid species feeding on both field and stored legumes. Several laboratory strains of this species show a variation in larval competition strategies along the "contest type" - "scramble type" spectrum. My hybridization experiment between contest and scramble strains of *C. maculatus* revealed that the two strategies were under control of additive genetic mechanisms. I further conducted intraspecific multiple-generation competition experiments with different bean size conditions to reveal relationship between population dynamics of hybrid lines and their genetic composition. I compare competition results with those of interspecific competition using other *Callosobruchus* species without any genetic interactions, and discuss the possibility that the underlying genetic mechanisms might not only delay selection scenario but also change the direction of the selection scenario per se.

CLADISTICS AND EVOLUTION OF BRUCHIDS INTO HOST SEEDS. C. D. Johnson (Box 5640-Biology, Northern Arizona University Flagstaff, AZ 86011)

This first comprehensive cladistic analysis of a taxon of bruchid beetles hypothesizes that there are two major monopyletic clades within *Stator* and the relationships of minor monophyletic clades are elucidated. Sufficient data are not available to determine if species in the genus have adapted to host plants by parallel cladogenesis (stepwise coevolution) because of the nature of the Leguminosae. There is ample evidence that colonization (=sequential evolution) has occurred. Legume seeds are replete with a variety of secondary chemicals which protect them. Seed chemicals undoubtedly play an important role in the cladogenesis and host specificity of bruchids and in the evolution of host preferences. Ovipositional behaviour may be another explanation for cladogenesis of bruchids.

BIOCHEMICAL RESISTANCE MECHANISMS IN LEGUMES TO BRUCHIDS AND THEIR EXPLOITATION IN PLANT BIOTECHNOLOGY. Angharad M. R. Gatehouse (Department of Biological Sciences, University of Durham, South Road, Durham DH1 3LE, UK) Elisabeth P.J. Burgess (DSIR Plant Protection, Private Bag, Auckland, New Zealand)

Within the plant kingdom there is a very great diversity of secondary metabolic pathways leading to the accumulation of a wide range of secondary compounds; this is especially true for the seeds of legumes which are a rich and varied source of such compounds. Insect attack on these seeds is primarily limited to a specialised family of insects, the Bruchidae, and different species within this family show varying degrees of specialisation with respect to host species.

A protective role for many of the secondary compounds present in legume seeds, both against bruchids and other types of insect, has been established and in recent years the utilisation of such compounds in crop protection, either by conventional plant breeding or by genetic engineering has been, and is being, investigated. Those compounds which at present are being exploited in plant biotechnology include insecticidal proteins such as enzyme inhibitors, lectins and lectin-like proteins. Examples of each of these will be presented and the future of this technology will be discussed.

NATURAL ENEMIES OF BRUCHIDAE FOR BIOLOGICAL CONTROL: A REVIEW.

Alebeek, F.A.N. van,
Department of Entomology, Wageningen Agricultural University, P.O. Box 8031, 6700 EH Wageningen, The Netherlands.

Several species of Bruchidae are field or stored product pests of grain legumes. Biological control of bruchid pests with natural enemies has received relatively little attention until now. The few biological control projects on bruchids, both from the past and those currently under way, are summarized. Our present knowledge of predators and parasitoids of bruchids is reviewed. Several catalogues list large numbers of natural enemies of Bruchidae. However, only from a few natural enemies the biology, behaviour, distribution and host range have been studied. These studies are reviewed. Based on this knowledge, the potentials and limitations of parasitoids and predators for the biological control of bruchids are evaluated.

LABORATORY POPULATION DYNAMICS OF BRUCHIDS AND THEIR PARASITIC WASPS. Koichi Fujii (Institute of Biological Sciences, Univ. Tsukuba, Tsukuba, Ibaraki 305 Japan), Takayuki Mitsunaga (Graduate School of Biological Sciences, Univ. Tsukuba, Tsukuba, Ibaraki 305 Japan)

We set up the basic laboratory experimental system, comprised of two species of beans, Azuki bean (*Vigna angularis*) and Red Kidney (*Phaseolus vulgaris*), and two species of bean weevils, Azuki bean weevil (*Callosobruchus chinensis*) and Mexican bean weevil (*Zabrotes subfasciatus*). *C. chinensis* females oviposit their eggs evenly on the two kinds of beans, but the hatched larvae die immediately after boring into Red Kidney bean. *Z. subfasciatus* larvae can develop well in both beans. In spite of this disadvantage of *C. chinensis*, the two bean weevil species could coexist for a long period. This was due to the competitive superiority of *C. chinensis* larvae (probably faster development) over *Z. subfasciatus* in Azuki bean.

Next, we set up more complicated system, by adding one of three wasp species parasitic on bean weevil larvae into the above 2-beans 2-bean weevils system. When we introduced *Heterospilus prosopidis*, the two weevil species and *H. prosopidis* could coexist for a long period. When *Dinarmus basalis* was added to the system, it overexploited both host species, and the system crashed. When *Anisopteromalus calandrae* was employed as parasitic wasp species, *C. chinensis* was soon eliminated from the system, and the stable system consisting only of *Z. subfasciatus* and *A. calandrae* was realized. We discuss the possible mechanisms which bring the different system behaviors depending on the parasitic wasp species.

EFFECT OF FOOD ON THE REPRODUCTION OF BRUCHIDAE (COLEOPTERA:INSECTA)

Amar Shobha & H.R.Pajni (Department of Zoology, Panjab University, Chandigarh-160 014, India).

Bruchid pests belong to two different categories which differ in respect of feeding and reproductive behaviour. The store bruchids from the genera Callosobruchus and Zabrotes do not feed in the adult stage and continue to reproduce without interruption. However, different species have a long range of host plants out of which each species shows highest reproductive capacity on a particular host. These hosts obviously represent the original host while the others in the range form secondary hosts. The store bruchids thus have a short developmental period and longevity, are multivoltine and have a long range of host plants. Moreover these bruchids never visits the fields for attacking their host. The field bruchids on the contrary, are host specific. They need to feed on the pollen of their respective host plants in order to be capable of starting reproduction.These bruchids largely come from the genera Bruchus and Bruchidius. The field bruchids show a very long developmental period and logevity, pass only one generation in the course of the year and go through a long period of imaginal diapause.

EFFECT OF RADIATION ON THE FEMALE SEX PHEROMONE GLANDS OF THE COWPEA WEEVIL, *CALLOSOBRUCHUS MACULATUS*(F.) (COLEOPTERA: BRUCHIDAE). I. I. Ismail, S. A. El-Maasarawy (Dept. of Econ. Entom., Fac. of Agric., Cairo Univ.), H. M. Roushdy and Mai S. El-Degwi (Nat. Cent. Rad. Res. and Tech. Egypt)

Irradiating the adults of the cowpea weevil, *Callosobruchus maculatus* (F.) at different doses of gamma radiation considerably affected sex pheromone glands of females. When irradiated the 4 or 6 day old females with 100 Gy the glandular cells were separated with demolish nuclei. As increasing the irradiation dose to 200 Gy, the glandular tissue is completely damaged and appeared as a narrow ribbon. The effectiveness of radiation on the female pheromone glands is an important factor that can be recommended for the control program of *C. maculatus*.

A SEED α-AMYLASE INHIBITOR AS A GROWTH INHIBITORY FACTOR IN THE COMMON BEAN TO BRUCHIDS (COLEOPTERA: BRUCHIDAE) Masao ISHIMOTO and Keisuke KITAMURA, Legume Breeding Laboratory, National Agriculture Research Center, Tsukuba, Ibaraki 305, Japan.

Seeds of the common bean (Phaseolus vulgaris) contain growth inhibitory substances which are responsible for the resistance to Callosobruchus chinensis and C. maculatus, major storage pests of cowpea, mungbean and adzuki bean. One of the inhibitory substances was purified from seeds of the common bean by a series of fractionation methods and feeding tests using artificial beans made of adzuki bean meal, and identified as a proteinous α-amylase inhibitor. The α-amylase inhibitor inhibited the amylase activities from larval midguts of the two bruchids, and markedly suppressed the larval growth when incorporated into the artificial beans. On the contrary, both of the larval growth and the larval midgut amylase of Zabrotes subfasciatus, a well known pest of common bean, were hardly affected by the inhibitor. The inhibitor was digested rapidly by the incubation with the larval midgut extract from Z. subfasciatus, but not those from C. chinensis and C. maculatus. The digestion might result in the inactivation of the α-amylase inhibitor.

BIOLOGICAL CONTROL OF STORE BRUCHIDS(BRUCHIDAE : COLEOPTERA)
H.R.Pajni(Department of Zoology,Panjab University, Chandigarh - 160 014, India)

The 3 common species of store bruchids viz. Callosobruchus maculatus(Fabr.),C.analis(Fabr.)andC. chinensis(Linn.) are attacked by an egg parasite, Uscana mukerjii(Mani). This parasite shows both bisexual and parthenogenetic development. A female can lay upto 30 eggs as compared to a maximum of 110 eggs by the bruchid females. Experiments show that when the individuals are added in 3:1 parasite/host ratio, there is achieved a complete control of the pest.Moreover,the introduction of parasite in equally spaced instalments in place of total introduction at one time,increases the efficiency of the parasite as biocontrol agent. The bruchid eggs being laid on the surface of the seed are easily located by the parasite. Moreover,the destruction of the host eggs affords damage free control of the host seeds/pulses. The mass rearing of the parasites on eggs deposited on the surface of petridishes has been found suitable to some extent. However,the formulation of a suitable artificial medium for the rearing of the parasites will be of crucial importance for commercial operation.Continuous selection for maintaining desirable level of fecundity in the parasite will also be required.

FECUNDITY AND COMPETITION IN THE COWPEA WEEVIL.
Rodger Mitchell (Department of Zoology, Ohio State University, Columbus, OH 43210, U.S.A.)

The ability of a female to disperse her eggs uniformly varies widely within the species and the trait can be measured with the index "U". Egg dispersion is the proximate response but it also determines how much competition will occur among the larvae. When the portion of offspring found in competition is correlated with "U" we find that "U" also measures the competition associated with the pattern of egg dispersion. Since competition can seriously reduce a female's contributions to the next generation, "U" is also a measure of the selective advantage of various patterns of egg dispersion. Larval competitiveness, measured as the probability of survival when 2, 3, etc. larvae compete, can be tested for its association with the degree of hyperdispersion. That association is examined for individual females and biotypes are compared.

ON THE ESSENCE OF PLANT QUARANTINE. Ji Cao (Chinese Academy of Agricultural Sciences, Beijing 100081, China)

All living organism is bestowed with the ability of self-expansion. Growth is expansive, and reproduction is even more so. One may say that the more expansive a species is, the fittest it is also. Man is a paramount exemple, next come those species which have whole or part of their life linked with man, and those live on plants, plant product or even soil are of plant quarantine significance, although their per se ability of expansion is low, they had conquered vast area of new territory simply by hitchhicking. Wherever there is trading of plant material, there is a chance for their invasion into new territory. It is on this dilemma lies the difficulty of plant quarantine.

Strengthening of plant quarantine must be done on a world-wide basis. It is suggested that: (1) the quarantine service of FAO should be authorized to function as a headquater of fighting against quarantine pests. She should be equipped with computerized network of intormation on those pests; (2) in developed contries, attempts should be made to unify plant quarantine (front line) and plant protection (rear line).

STATUS OF QUARANTINE ENTOMOLOGY IN CHINA. Wen-guo Yao (Headquarters of Animal and Plant Quarantine of P.R.C., Beijing 100026, China)

This paper presents the status of Quarantine entomology in China. Four parts are given: (1). The characteristics of chinese plant quarantine organization, its formation and manipulation as well as plant quarantine system composed of inspection, decision-making, investigation and personnel training. (2). A list of plants which are to be prohibited from free entrance, our policy against notorious pests, namely, medfly, rice water weevil, khapra beetle, etc. (3). Facts about destructive insects captured from imported cereals, cotton, lumbers, fruits and transportation facilities from 1986 to 1989, 15 quarantine objects are found from 1,000 loads and 1,000 other pests are captured from 20,295 loads. and (4). The recent advances in the identification and surveillence of quarantine insects. Besides, it gives ways to extinguish unwanted insects, such as the development of vacuum fumigation, shipload fumigation, circular fumigation in silo bin, sulphury flouride production and application, etc. Reseach is also being made in the using of high-frequency wave, microwave and radioactive wave for treating impoorted plant materials by way of postal parcel and/or by passengers

TOWARDS INTEGRATED CONTROL OF THE LARGER GRAIN BORER: ACTIVITIES OF IITA AND COLLABORATORS. R.H. Markham, N. Bosque-Perez & C. Borgemeister (International Institute of Tropical Agriculture, Ibadan, Nigeria), J. Trujillo & R.M.Rios (Colegio de Postgraduados, Chapingo, Mexico), V.F. Wright & P. Novillo (Escuela Agricola Panamericana, Tegucigalpa, Honduras)

In response to the severe damage caused to stored maize following the accidental introduction to Africa of the larger grain borer *Prostephanus truncatus* (Col.: Bostrichidae), governments and international agencies have concentrated on chemical control and classical biological control of the pest within affected areas, combined with statutory measures to restrict its spread. Socio-economic constraints have limited the impact of the first strategy, especially in West Africa, whilst ecological studies in the pest's area of origin, by the International Institute of Tropical Agriculture (IITA) and collaborators, have indicated likely limitations on the success of the latter two approaches.

Studies using pheromone-baited flight traps indicate that larger grain borer is widespread and abundant, even outside maize production areas, and that it has a strong seasonal pattern of flight activity, independent of the maize production and storage cycle. Factors which lead larger grain borer to initiate destructive attacks on stored maize are not clear, but field infestation was low or undetected at our two study sites. Once in a maize store, the pest's rapid population increase does not reach equilibrium with that of its predator, *Teretriosoma nigrescens* (Col.: Histeridae).

Our research priorities are now to: 1) investigate the pest's host-finding behaviour and how this interacts with farmers' practices to determine the initial level of infestation of stored maize; and 2) to quantify and model the factors (climate, maize varieties, competition, natural enemies) which determine the pest's subsequent increase in store. This knowledge will provide a sound basis for implementation of an integrated control strategy.

DEVELOPMENT OF FUMIGANT, TECHNIQUES AND EQUIPMENTS OF FUMIGATION, A COMPREHENSIVE STUDY. Guo-gan Xu, et al (Plant Quarantine Institute of Agriculture Ministry, Beijing 100026,China), Shou-tian Li, Jiang-shan Zhao, et al (Hebi Instrument Manufactory, Henan Province 456640, China).

Sulphury fluoride (SO_2F_2) has been developed and applied in agriculture, forestry, foreign trade, archives, textiles and buildings. Because of the very low boiling point(-55.20C), SO_2F_2 can be used as fumigant at low temperature. Generally SO_2F_2 is very toxic to all postembryonic stages of insect. No harmful effect is found upon the germination of fumigated grain, cotton, vegetable and forest seeds. Vacuum fumigation with CH_3Br, C_2H_4O or SO_2F_2 has been indicated effective and safe to control stored product pests for plant seeds or animal and plant disease.Besides, we have developed recirculate-fumigating technique of CH_3Br to stored grain pests in silo bin, designed with air replaced for 2 or 3 times in an hour, air flowing at about 18m/sd. in duct, at least 0.02-0.04m/sd. in grain stack. The CT (g/m^3 X h) for CH_3Br to control pests in stored grain are as follows: 670-700/10-15°C, 500-525/16-20°C, 435-460/21-25°C. ZX-350 Vacuum Fumigator, PCV-1500 Program Controlled Vacuum Fumigator, PD-1 Pest Treating Machine and the recirculation equipments for CH_3Br fumigation in silo bin have been developed and already in use.

SUGGESTIONS TO THE ENTOMOLOGICAL WORK IN PLANT QUARANTINE NURSERIES IN CHINA. Guan Lianghua,Cheng Shitian, Wang Zongwei, Jiang Zhongming (Tianjin Animal and Plant Quarantine Service, Tianjin 300456,China)

Three categories of entomological work in plant quarantine nurseries,namely,supplementary work,main work and routine work are suggested. Supplementary work is related to plant disease objects such as fungus disease (Elm dutch disease), bacterial disease (Bactenal wilt of corn) and nematode disease (Pinewood Nematode), and many insect-borne plant disease,especially virus disease. Phytopathology inspection and treatment of plant disease can't be done well without supporting of insectan work.

Main work is primarily concerned with insect objects of Chinese plant quarantine such as grape phylloxera, codling moth etc. Its importance is self-evident.

The working objects of these above mentioned are in cope with the object list of Chinese plant quarantine. Routine work is subject to local conditions of China. It is difficult to set one general standard usable to all nurseries in China, because china is so vast. However, normally we can divided it into two types, that is South China type and North China type.

A STUDY ON ORIENTAL FRUIT FLY IN SICHUAN PROVINCE. Yu-an Zhang, Xue-qian Zhao (Plant Quarantine Service, Department of Agriculture and Animal Husbandry of Sichuan Province, Chengdu 610041, China)

By means of chemical attractants(methyl eugenol), foodlure, net capture, raising from various infested fruits and survey of localities, Dacus dorsalis (Hendel) was investigated in Sichuan. The result of the present report is summarized as follows:

1. The geographical distribution of the pest only is present in limited 12 counties in Southwest Sichuan, and mainly present in 10 counties of Pan-Xi District.

2. The only known hosts of the pest are fruits of mango, pear, apple, peach and guava. However,the pest have not been found to attack citrus, melon, tomato, egg plant and pepper in Sichuan up to now.

3. D. dorsalis has 2-3 generations per year in Sichuan. It overwinters as a puparium in soil. Emergence begins at the begining of June. The declining period is mid-November. There are 3-4 peak periods a year. The ratio of female and male is 1.09 to 1.

4. The plant quarantine programme against D. dorsalis is a critical and urgent task. The programme covers the activities of further survey, consignment inspections, regulatory management and control measures.

Regional programme in southern and eastern Africa to restrict the effect of the Larger Grain Borer, *Prostephanus truncatus* (Horn) on the trade in maize. P. Golob (Natural Resources Institute, Chatham, Kent ME4 4TB, UK), G.G.M. Schulten (FAO, 00100 Rome, Italy).

The Larger Grain Borer (LGB) was first introduced to Africa, into Tanzania, less than 20 years ago. This beetle can have a devastating effect on farm-stored maize. Storage losses of 10% heve been recorded in less than 6 months and many farmers have sustained losses of 30% or more. Dispersal of the pest has been shown to be mainly through trade, either by the transportation of infested maize or dried cassava into previously uninfested regions or by the carriage of empty sacks harbouring live beetles. Three countries in the region, Tanzania, Kenya and Burundi, are known to be infested. The megnitude of the losses are so great - as much as five times whet would be expected where LGB is absent - that neighbouring countries heve refused to accept exports of maize from infested countries. Donor organisations experienced difficulties in supplying food eid to deficit countries in the region from surpluses produced by countries where pest hss now become endemic. The EC commissioned a study by NRI to examine the grain trade in the region with the main objective being to facilitate the intraregional movement of grain, to stimulate trade between netions. Recommendations were made to improve pest management practices at points of export and to enhance inspection and regulatory procedures. Training of key personnel will be an essential component of the programme. Implementation of the recommendations should enable nationa and donor organisations invovled with grain movement to operate in the knowledge that imports would be free of live LGB.

ANALYSIS AND QUARANTINE TREATMENT ON INTERCEPTED PESTS AT THE PORT OF TIANJIN. Sen Zhao, Shao-jun Yang (Tianjin Animal and Plant Quarantine Serviec, Tianjin 300456, China)

The purpose of plant quarantine is to prevent any dangerous pests into China. The port of Tianjin is one of the biggest sea-ports in China. A total of 144 insect species, which belong to 11 orders, 46 Families, 101 Genera, have been intercepted in the imported goods through the port of Tianjin during the last 25 years period. 54% lots of imported agricultural products were infested with living insect pests, 10% lots of the infested imports, that is 127 lots were infested with insects of plant quarantine objects which conform with lists published before 1991.

Fumigation is an important means of eradicating insect pests in the imported goods. Now we use aluminium phosphide to get infested import of grains fumigated in the elevator and we have found that fumigation in the elevator is more effective than on a ship.

The paper places emphasis on a list of intercepted insects, including host coommodities and countries of origin.

POSSIBLE DISTRIBUTION AND ESTABLISHMENT OF THE MELON FLY DACUS CUCURBITAE COQ. IN XINJIANG, CHINA. Jun Zhang (Hangzhou Animal and Plant Quarantine Service, Hangzhou 310021, China), Rui Gao (Urumqi Animal and Plant Quarantine Service, Urumqi 830011, China)

The Melon fly is a serious pest of various vegetable crops in south China but it is not known to occur in Xinjiang, China. The bioclimatic studies had been made to determine their possible distribution and establishment in these areas. The developmental zero and total effective temperature accumulation from egg to adult emergence were 10℃ and 650 day-degree, respectively. In Xinjiang, during the winter, from Nov. to March the temperatures drops to -10℃, the deep of soil freexing was at 43-115cm and fruit flies development activity are interrupted thereby. The favorable temperatures for the development and reproduction of fruit fly is from April to October. It seems that the fruit flies can not overwinter in these areas.

QUARANTINE DISINFESTATION WITH HEAT FOR AUSTRALIAN FRUIT FLIES N.W. Heather, R.J. Corcoran, (Department of Primary Industries, Meiers Road, Indooroopilly, Qld, Australia 4068) and Tang Zhi, (Plant Quarantine Institute, Ministry of Agriculture, Liangmaqiao, 10026, Beijing, China)

Heat disinfestation schedules are being developed for use as quarantine treatments against Australian fruit flies in fruits to be exported. Both heat and cold treatments have the advantage of freedom from residues but heat treatments are much faster than cold treatments with consequent marketing advantage. Hot air disinfestation schedules have been completed for mangoes against Queensland fruit fly, *Bactrocera tryoni* (Froggatt) and for zucchinis against cucumber fly *B. cucumis* (French). Others in the course of development include lychee, mangoes, melons and tomatoes. Development of a schedule requires techniques to infest fruit in the laboratory, data on the life cycle of the fly species in the fruit to be tested, estimation of the time/core temperature combination required to achieve the required level of efficacy in terms of insect mortality at the most tolerant stage of development present in fruit e.g. Probit 9, and trials to confirm the efficacy at the 95% confidence level. For mangoes the treatment required against *B. tryoni* is 46.5°C held for 10 minutes and for zucchini against *B. cucumis*, 45°C held for 30 minutes. Both treatments use a chamber air differential of 1°C and humidity of 95%. The experiments were conducted in a pilot scale "Sanshu" vapour heat system. Also under development for mangoes are hot water dipping disinfestation schedules.

RECONCILING PEST RISK, QUARANTINE SECURITY AND DISINFESTATION EFFICACY FOR HORTICULTURAL PRODUCE: AN EXPORTERS VIEWPOINT. N.W. Heather (Department of Primary Industries, Meiers Road, Indooroopilly, Qld. Australia 4068)

Pest risk in commercial produce is normally much lower than in fruit & vegetables which might be carried by travellers. This is due to the quality standards which commercial fruit must meet for consumer acceptance even in areas which have no quarantine conditions. The lower risk of infestation, together with the relative ease of surveillance and inspection of commercial fruit needs to be recognised in setting efficacy standards for dis-infestation treatments. Historically, quarantine security requirements have tended to reflect the efficacy of the best treatment available and there is an urgent need for research to establish pest risk data on which to base quarantine security requirements. Treatments should be the minimum required to achieve overall quarantine security and should not damage the produce nor should they be unnecessarily expensive or complex. The criteria used in assessing the efficacy of disinfestation treatments are most important. It is necessary to recognise that the primary intent of the treatment is quarantine security, not prevention of damage by infestations in fruit. Mortality is the usual criterion for treatment efficacy but for fruit it is accepted that sterility of adults or physical impediments to mating and reproduction can also achieve the purpose of quarantine disinfestation treatments.

COMPUTER BASED TRAINING AND SUPPORT FOR QUARANTINE INSPECTORS.
J.W. TURNER (Department of Primary Industries, Meiers Rd., Indooroopilly, Brisbane 4068, Australia)

Identification of insects is a visual skill, Computer graphics provides a flexible way of presenting still photographs and drawings as well as live video and cartoons for training Quarantine Inspectors in the identification of insects as well as providing rapidly accessible support information.

A graphics library is being built using the wide range of material available to the Australian Quarantine and Inspection Service. It will be exploited using existing programs such as slide shows, expert systems, databases, CSIRO's INTKEY, CABIkey, and a range of computer based learning programs. Desk-top video programs can be used to output information to videotape.

The rapid advances in technology, particularly in multi-media and compression of files along with an increasing number of programs, will make this approach more flexible and economical.

STUDIES ON TECHNIQUE OF INSECT QUARANTINE AND TREATMENT FROM IMPORTED LOGS. Guo-yao Jiao, Ke yuan(Nanjing Animal and Plant Quarantine Service, P.R.C., No.44 Matai St., Nanjing 210009, China)

A large number of logs from nearly every corner of the world have been inspected by Nanjing Animal and Plant Quarantine Service since 1983. More than 140 species of insect pests have been intercepted from these imported logs, some of them are quarantine objects such as *Scolytus multistriatus* Marshman, *Coptotermes curvignathus* Holmgren, *Heterobostrychus aegualis* etc. For that, fumigation or soaking are used immediately at entry port as the requisite quarantine treatments. This article elaborates the main species of the dangerous forest insect pests we found and the techniques of quarantine treatment. By analysing the risk of insect pests in imported logs, and in view of the weak links in our quarantine work at present, it is suggested to take further steps to study on quarantine identification and treatment technique (e.g. SO_2F_2 fumigation) of insect pests within imported logs.

QUARANTINE AND ITS TREATMENT MEASURES OF LONG-HORNED BEETLE (*COLEOPTERA: CERAMBYCIDAE*) ON IMPORTED LOG. Ming-guang Lin, Jiang-jiang Lin, Chi-xian Ye, Zhi-yong Li (Haikou Animal and Plant Quarantine Serviec, Haikou 570011, China)

In the present paper the quarantine research work of cerambycid pests on imported log found in the years 1982-1990 was stated. We conducted the study on the morphology, distribution, host, damage and habit of the four dangerious Malysian long-horn beetles intercepted on imported logs at Haikou, and put forward whole set of practical and economical quarantine and its treatment measures for the cerambycid pests in imported log. The treatment measures are: a) disbarking; b) splitting off sapwood; c) sawing logs into planks; d) spraying insecticides; e) limitation of the disposing areas; f) fumigation.

STUDY ON VACUUM FUMIGATION TECHNIQUE FOR TREE SEED PESTS. Bu-gu Gao, et al (The General Station of Forest Pest and Disease Control, Ministry of Forestry, 58 Northern Huanghe st., Shenyang 110031, China)

Larix gmelini seeds with *Eurytoma Laricis*, *Caragana microphylla* seeds with *Kytorrhinus immixtus*, *Amorpha fruticosa* seeds with *Acanthoscelides plagiatus*, *Robinia pseudoacacia* seeds with *Bruchophagus philorobiniae*, *Cryptomeria fortunei* seeds with *Megesligmus cryptomeriae*, and *Gleditsia sinensis* seeds with *Bruchidius dorsalis* were treated respectively at 15-19°c and 730-740 mmHg vacuum in a fumigator (type zx-350), using 50g/m^3 dose of CH_3Br/SO_2F_2 for 3 hours, 100% larvae of *Eurytoma Laricis*, *Bruchophagus philorobiniae*, and *Megesligmus cryptomeriae* in seeds were killed. Using 60g/m^3 dose of CH_3Br/SO_2F_2 for 3hr., 100% larvae of *Acanthoscelides plagiatus*, *Kytorrhinus immixtus*, and *Bruchidius dorsalis* in seeds were killed. There is no evident detriment to germination of seeds. With the same dosage of fumigants at 32-34°C, The fumigation time was shortened, but the germination rate of seeds was much reduced. The side effect of repeated fumigation at 15-19°C on germination of seeds is not evident; but that at 32-34°C is distinct.

FRUIT FLIES OF ECONOMIC IMPORTANCE OF THE GENUS *DACUS* IN GUANGZHOU AND NEARBY REGION. Guang-qin Liang, Wei Xu, Fan Liang (Guang Zhou Animal and Plant Quarantine Serviec, No.82, Zhan Qian Rd. Guangzhou, China)

There are three species of fruit flies of economic importance in Guangzhou. They are the oriental fruit fly, *Dacus dorsalis* Hendel, the melon fly, *Dacus cucurbitae* Coq., and the pumpkin fly, *Dacus tau* Wallker. The oriental fruit fly has a very wide host range, it apparently attacks all types of flesh fruits. The melon fly and the pumpkin fly seriously injure cucurbitaeceous plants. According to the survey in Guangzhou from 1980 to 1990, the oriental fruit fly does not occur every year. It seems to have intermissions. As to the melon fly and the pumpkin fly, the former has not been found during early 1980s in fixed-survey positions until 1987; the latter has been caught by Cuelure trap every year but the population of the melon fly was less than that of the pumpkin fly.

The results of monitoring after many years show that the occurring of the melon fly in Guangzhou reached a high population in some years and it was hard to find in some other years. The three species of economically important fruit flies in Guangzhou are not in their damage to crops serious. Because the farmers control them along with other insect pests in fields or in gardens. Thus the fruit flies do not injure crops seriously.

FORESTRY PRODUCTS QUARANTINE IN MANZHOULI PORT OF CHINA. Jian-guo Zhang (Manzhouli Animal and Plant Quarantine Service, China 021400)

A great number of logs and sawn timber are imported from USSR every year in Manzhouli port of China. It has been inspected and quarantined while entry the port. There are also many wooden packages that were imported with many kinds goods from the world. The main pests with logs and sawn timber is *IPS* spp, *Orthotomicus* spp and *Pityogenes* spp, 14 species of ambrosia beetles (*Platypodidae* and *scolytidae*) and 4 species wood boring insects and 3 species weevils were intercepted during the period 1987-1990 are listed. The problems for quarantine officer at port are pointed out. Some new aspects in forest insects is discussed. The purpose and reason of built PRA system is discussed in this paper.

STUDIES ON TECHNIQUE OF INSECT PEST QUARANTINE AND TREATMENT OF ENTERING PASSANGERS AT CAPITAL AIR PORT. Yi-jun Wang, Hong-jun Chen(Capital Airport Animal and Plant Quarantine Service, Beijing 100621, China).

A large number of passangers enter Beijing from overseas every year. varied plants and their products are carried by them, sometimes there are pests complicated epidemic situation in foreign countries may be rapidly brought into China. Since 1980-1991,more than 70 species of insect pests have been intercepted, some of them are quarantine objects or local distribution in China, such as *Sternochetus mangiferae*(F.), *Callosobruchus ademptus*(Sharp) etc. which we have treated by fumigation or radiation.

TEST ON FUMIGATION AND VENTILATION BY COMMON PIPELINE IN SILO BIN. Jian-hua Lui, Shu-tian Hu, Qin Liu(Tanggu Grain Depot of Tianjin municipality); Dong-sheng Hu, Ren-zhi Li(Tanggu Grain Bureau of Tianjin municipality)

We have been entrusted by Grain Bureau of Tianjin, to design and test on a common pipeline fumigation or ventilation. This equipment consists of a gas generator of methyl bromide, a common pipeline and an air-tight silo bin. Lastly, we have to determine the residual amount of methyl bromide and the possibility of its reuse.

The test was taken place from June 1990 to August 1991 at Tanggu grain depot. A positive result was obtained. As the construction design is reasonable; the efficiency of fumigation was high all the test insects were killed. As long as the temperature of gaseous mathyl bromide is elevated above 15°c, it can be used in all seasons. The amount of the fumigant available was found to be 2308.5g per silo for one test. At such a low dosage of the fumigant, no environmental contamination occurred.

STUDIES ON BIONOMICS AND FUMIGATION OF ALFALFA SEED CHALCID(*BRUCHOPHAGUS RODDI* GUSSAKOVSKII). Bao-cheng Shen(General Station of Plant Protection of Shaanxi Province, Xian 710003, China)

The paper presents the main bionomics and technique of fumigating alfalfa seed chalcid in northern Shanxi Province. The adults occurred on peak in two periods, early June and middle July. It was effective to fumigate with sulphury fluoride(SO_2F_2) at 50g/m^3 for 72 hrs. or the mixture of SO_2F_2 at 25g/m^3 and ALP at 15g/m^3 for 24hrs.

QUARANTINE INSPECTION OF INSECT VECTORS OF PLANT VIRUS OF QUARANTINE IMPORTANCE. Zhi-nan Chen (Shenzhen Animal and Plant Quarantine Service, Shenzhen 518001, China), Liang-hua Guang(Tianjin Animal and Plant Quarantine Service, Tianjin 300456, China)

This paper reports the past and the present situation of the insect-vectors (aphids, leaf-hoppers and mealybugs, etc.) of China's plant quarantine virus (SMMV,CSSV, etc.) with reference to their geographic distribution, physiology and ecology. A schedule for inspection and treatment of these insect vectors has been developed based on their specific bionomics, the regeneration of the virus in insect vectors and the distribution of insect vectors so far reported in China. This paper analyze the possibility that the insect vectors and the plant virus concerned could be carried into China in course of the international germplasm exchange. By analysing a typic system, namely Soybean mild mosaic virus by Myzus persicae, a quarantine inspection schedule of insect vectors in China was suggested.

QUARANTINE ASPECT OF THE INSECT VECTORS ASSOCIATED WITH NEMATODES IN CHINA. Wei-dong Yang(Shenzhen Animal and Plant Quarantine Service , Shenzhen 518001, China), Liang-hua Guan(Tianjin Animal and Plant Quarantine Service of PRC,Tianjin 300456, China).

The palm weevil, *Rhyncophorus palmarum*, is the known vector of the red ring disease of coconut palm, *Rhadinaphelenchus cocophilus* and the pine sawyer, *Monochamus alternatus*, is the most significant vector of the pinewood nematode, *Bursaphelenchus xylophilus*. They are the only two reported cases of insect vectors playing a primary role in the spread of the wood plant nematode disease up to now. The two insect vectors and two nematodes mentioned above all belong to the quarantine objects promulgated by Chinese Government. In this paper, the biology of the insect vectors, the transmissions are reviewed. Different from other insects, the quarantine and treatment of the insect vectors associated with nematodes should be taken under the consideration of insect and nematode. The inspection procedure of the insect vectors is recommended in this paper based on the biological distributions, the symptoms of the plant affected by insect vectors and nematodes. The efficient quarantine treatment of them is also suggested.

EXPERIMENT ON IRRADIATION OF LYCHEE FOR QUEENSLAND FRUIT FLY *BACTROCERA TRYONI*(FROGGATT). Chao-sen Lin (Shenzhen Animal and Plant Quarantine Service , Shenzhen 518001, China), Neil W. Heather(Agricultural Laboratory Department of Primary Industries, Queensland, Australia)

Egg hatching rate and the folloing first instar generation were not influenced after eggs were irradiated by a dose of 75 Gy gamma irradiation at an egg age of 28 hours. But the growing process of third instar larvae from irradiated eggs was seriously disturbed. Duration of these third instars was extended to over 10 days and only about 3.4% pupated. These pupae all died before emergence. Mature larvae which were irradiated at 75 Gy dose could pupate rapidly, but soon the mouth part and head of these pupae darkened and decayed. No one could emerge. Pupae, at 5-6 days age, 26°c, irradiated with 75 Gy could emerge, but the mortality of irradiated pupae and adult from irradiated pupae was 39.4% within 14 days of irradiation. Dissection of adults emerged from irradiated pupae showed that the ova and tests were highly atrophied. Results of experiments on irradiation induced sterilisation on pupae at 75 Gy dose of gamma irradiation showed that no egg was collected. Lychees infested by larvae and egg in three trials of irradiation disinfestation were irradiated at 75 Gy. Results of these experiments show no emergence fruit fly. The mortality of irradiation lychee with larvae and egg was probit 8.7 and probit 9 with 95% confidence, respectively.

SEXUAL AND PARTHENOGENETIC REPRODUCTIVE POTENTIAL IN FOUR PERIPLANETA SPP. Patricia A. Zungoli, Theresa M. Pizzuto, and Katherine A. Luhring (Department of Entomology, Clemson University, Clemson, SC 29634-0365 USA)

A study was conducted to investigate the sexual and parthenogenetic reproductive success of four Periplaneta species - P. americana, P. australasiae, P. brunnea, P. fuliginosa. Data were recorded on numbers of oothecae produced, hatch success and nymphal survivorship and development to the adult stage. Sexual reproduction was substantially higher than that previously reported in the literature, especially for P. americana. Parthenogenetic reproduction was observed in all species with P. brunnea, being the most successful, followed by P. americana. Parthenogensis was observed in P. fuliginosa and P. australasiae, but success rate was low. Parthenogenetic F_1 P. brunnea and P. americana consistently survived to the adult stage.

EFFECTS OF UV LIGHT ON COCKROACHES. K. Okamoto (Dept. Med. Zool., School of Health Siences, Fujita Health Univ., Toyoake, Aichi, 470-11, Japan)

Three aspects on the mode of action of UV light were examined in cockroaches.

I) Inhibitory effect on formation of the ootheca: UV-sensitive stage in formation of the ootheca, UV-reception site and transmitting route of UV stimuli were examined through various experiments. The results suggested that UV stimuli, received by the nerve-like structure under the antacoria at the base of antenna, activated the corpora allata, the function of which is normally restrained by the brain during formation of the ootheca. Juvenile hormone counteracted the secretion from colleterial glands.

II) Lethal effect on the adult German cockroaches: Dose-response relationship was examined using 6 kinds of UV irradiation regimes. The results showed that the lethal effect accumulated and that photo- and dark-recovery phenomena were absent in the adult German cockroaches. Results of the partial UV irradiation indicated that UV-reception site was located on the head.

III) Direct or indirect lethal effects on the 1st instar nymphs: Dose-response relationship in the 1st instar nymphs of different ages(in days) was examined. Direct lethal effect and inhibitory or delaying effects on the nymphal molt were closely related with their age and UV dose. Juvenile hormone analogue treatment was also shown to give lethal effect to the adults, direct or indirect lethal effects to the nymphs as observed in UV light.

Nocturnal behavior of German cockroaches,
Blattella germanica at feeding sites

AkiHiro KANAYAMA and keiko HIROSE
(Yokohama City Institute of Health)

The nocturnal behavior of German cockroaches, Blattella germanica at feeding sites was investigated using a behaving container connected with a harbouring box under laboratory conditions.

The appearance rate of cockroaches except gravid female at feeding sites was nearly constant regardless of the released number of cockroaches into the harbouring box.

The nocturnal behavior of adult males was very active and adult males widely dispersed throughout the behaving container.

Ungravid females were much more active than gravid ones, a few of which appeared at feeding sites at night.

DEVELOPMENT OF EFFECTIVE INSECTICIDAL BAITS FOR COCKROACH CONTROL. Chen-Shek Yu, The Clorox Company (7200 Johnson Drive, Pleasanton, CA 94588, U.S.A.)

Insecticidal baits have gained increasing popularity among professionals and consumers as effective means for cockroach control. Cockroach baits afford the advantages of focused, low level insecticide usage, long residual performance, negligible odor, convenience and when properly containerized, safety. A safe and effective cockroach bait depends on the successful selection of insecticide, food matrix and a suitable container. The process and techniques for developing an effective and commercially viable insecticidal bait for cockroach control are discussed.

BAIT TECHNOLOGY IN GERMAN COCKROACH CONTROL. Shripat T. Kamble and Suresh K. Prabhakaran (Environmental Programs, University of Nebraska, Lincoln, NE 68583-0818, USA)

The research was undertaken to evaluate the field performance and residual effect of chlorpyrifos, sulfluramid and hydramethylnon in bait formulations to control German cockroaches in multifamily apartment complexes. Six treatments included MaxForce (hydramethylnon 1.65% AI), 12 baits; Raid Roach controller (chlorpyrifos 0.5% AI), 12 baits; Raid Max (sulfluramid 1.0% AI), 12, 18 and 24 baits; and control (check). Each treatment had at least 13-20 replications. Raid Max and MaxForce provided averages of 70 to 79% reduction in German cockroach populations that resulted from the 12 week study. Approximately 12 baits stations placed in kitchen, bathrooms and pantry having light to moderate roach infestations seems to yield satisfactory control. An increase in number of bait stations per unit did not proportionately increase the percent reduction. Based on these results, baiting technology may offer an option for safe and reduced use of insecticides.

INFLUENCE OF POST-CONTACT COCKROACH BEHAVIOUR UPON EFFICACY OF RESIDUAL CONTROL TREATMENTS. A.J. Adams, R.J. Bowyer, A. Cleverly (Wellcome Environmental Health, McIntyre House, High Street, Berkhamsted, Herts HP4 2DY, England).

Numerous factors influence the quantity of active ingredient that is transferred from residual insecticide spray deposits to cockroaches, upon contact. However, the efficacy of the acquired insecticide is not necessarily dose-related. Post-contact behaviours, which may or may not be induced by the insecticide, affect the speed, duration and frequency of contact with residual deposits, and also any transfer of dose between individuals. Under laboratory conditions, female Periplaneta americana that contacted a residual deposit of a pyrethroid were able to transfer a lethal dose to untreated males, without becoming knocked down, themselves. Similarly, in different sized groups of P.americana, inter-cockroach transfer was able to compensate for a 25-fold range in available residual dose per insect, and cause equivalent knockdown times. The behavioural consequences of insecticide acquisition are an integral part of, and can make a significant contribution to, treatment efficacy.

MANAGEING INSECTICIDE RESISTANCE IN FIELD POPULATIONS OF GERMAN COCKROACHES. William H Robinson (Urban Pest Control Research Center, VPI&SU, Blacksburg, VA 24061 USA)

Controlling infestations of the German cockroach, Blattella germanica (L.), is becoming more difficult with the increasing presence of insecticide-resistant populations in urban environments. This pest can develop moderate to high-level resistance to insecticides after limited or extended exposure. Programs for managing pyrethroid resistance in German cockroach populations include mixtures and rotating the use of different classes of insecticides. Insecticides selected for mixtures or rotations must be capable of providing effective control of the resistant cockroaches, and have limited ability of producing resistance in the target population. The objectives of the research reported are to evaluate the effectiveness of several insecticides to suppress infestations of cypermethrin-resistant German cockroaches, and to assess the usefullness of including this insecticide in resistance management programs for German cockroaches. The insecticides evaluated included abamectin, chlorpyrifos, silica gel, diazinon, and two insect growth regulators. They provided limited to excellent control of the cypermethrin-resistant field population.

GERMAN COCKROACH MOVEMENT BEHAVIOR. Gary W. Bennett and Joe J. Demark (Center for Urban and Industrial Pest Management, Purdue University, West lafayette IN 47907-1158)

A basic understanding of german cockroach behavior will ultimately lead to superior management techniques. The utilization of computerized moving image analysis (MIA) provides a unique opportunity to monitor detailed accounts of this insect's behavior for entire life stages. MIA allows us to understand both how and why this insect behaves and satisfies its physiological needs. MIA works by following an insect with a video camera and reporting its x and y coordinates at a given time. The data from insect movement (over time) is digitized and then analyzed with the aid of computer programming. MIA was used to monitor the number of visits per hour and the total length of time that a German cockroach (both nymphs and adults) spends at food, water and harborage locations in both light and dark photoperiods (continuously as a lifestage progresses.) Food and water consumption was also measured.

THE DIFFERENCES IN CONTRIBUTION OF *KDR* FACTOR ON THE THIRD CHROMOSOME TO THE RESISTANCE OF SOME PYRETHROIDS IN HOUSEFLIES. Takada, Y.; Kawada, H.; Hirano, M. (Agricultural Science Research Laboratory, Takarazuka Research Center, Sumitomo Chemical Co.,Ltd., Takarazuka, Hyogo *665*, Japan)

We investigated the contribution of *kdr* factor on the third chromosome to the resistance of some pyrethroids in permethrin selected Akagi PP15 strain of houseflies.

The resistance to the pyrethroids with 3-phenoxy benzyl alcohol moiety was much associated with *kdr* factor. On the other hand, the contribution of *kdr* factor to the pyrethroids with aliphatic alcohol moiety was much less than that of the pyrethroids described above. Furthermore, the contribution of *kdr* factor to the pyrethroids with cyclopentenolone or hydantoin alcohol was intermediate between those of both types of pyrethroids.

In contrast, the contribution of the *kdr* factor was not concerned with acid moiety of pyrethroids tested. Therefore, the differences in contribution of *kdr* factor on the third chromosome to the pyrethroids are thought to be dependent on the alcohol moiety of them.

DIAPAUSE IN URBAN COCKROACHES. H. TSUJI (Agricultural Chemicals Research Laboratories, Sankyo Co., Ltd., 1041 Yasu, Yasu-cho, Yasu-gun, Shiga-ken 520-23, JAPAN)

Periplaneta japonica nymphs enter facultative diapause in the 2nd instar, and many of them seem to enter obligatory diapause in the final (9th) instar in Central Japan. P. fuliginosa nymphs also enter facultative diapause in the 2nd instar, and obligatory diapause in the penultimate (7th) or final (8th) instar stage. Many of P. fuliginosa eggs laid in late autumn are able to overwinter and produce new nymphs in spring. The new nymphs, together with the post-diapause 2nd instar nymphs, grow into the penultimate (7th) or final (8th) instar stage and overwinter again. The diapause phenomena seem to make these long-life-span cockroaches, both males and females simultaneously, emerge into adults in early summer, giving them better opportunities of finding their partners to mate with, and resulting in their effective reproduction.

P. americana and Blattella germanica, without entering diapause at any stage in their life-cycle, are easily killed by exposure to low temperature. The occurrence of these tropical species in Central Japan depends on the effects of artiflcial heating in buildings in winter.

S-41311 AS THE PROMISING COCKROACH CONTROL AGENT WITH HIGH KNOCKDOWN ACTIVITY AND THE NEW METHOD FOR EVALUATION OF KNOCKDOWN EFFICACY. Senbo, S.; Makita, M.; Kawada, H.; Hirano, M.; Abe, Y. (Agricultural Science Research Laboratory, Takarazuka Research Center, Sumitomo Chemical Co., Ltd., Takarazuka, Hyogo *665*, Japan)

Knockdown effect is one of the important property of cockroach control agent. Knockdown time (ex. KT_{50}) has been generally used to evaluate the knockdown effect. However, the linear correlation between the knockdown time and the amount of insecticides becomes undistinguishable when KT_{50} value becomes smaller, because of increasing error in observation. For this reason, the new evaluation method was attempted to measure the distances between spray point and the sites where cockroaches knocked down.

We could get good correlation among the moving distance of cockroach and the amount of insecticides examined in our study. S-41311, the new synthetic pyrethroid, showed the highest effect among the insecticides examined. The moving distance (MD_{50}) of 1.0% S-41311 was less than 10 cm against German cockroaches.

FACTORS REDUCING THE EFFICACY OF PYRETHROID INSECTICIDES FOR GERMAN COCKROACH CONTROL. D. Reierson and M. Rust (Department of Entomology, University of California, Riverside, California 92521, U.S.A.)

Blattella germanica (L.) is an extremely troublesome urban pest. We verified this pest in 66% of >100 restaurants we surveyed in southern California, U.S.A.

Conventional practice for controlling B. germanica involves contact and residual insecticide. Pyrethroid insecticides are ideal because they produce effects at low dosages, are stable indoors, have low volatility, do not translocate, and most have low mammalian toxicity. It was hoped that, as a new category of insecticide, pyrethroids could retard induction of insecticide resistance. Unfortunately, the level of cockroach control achieved with pyrethroid insecticides falls short of potential. Pyrethroids are excellent contact toxicants, but have extraordinary lipid affinity. They bind to grease, oils and paint and are then unavailable to insects walking on them. Also, pyrethroids are highly repellent, causing avoidance of otherwise lethal deposits.

Insecticide resistance also increases B. germanica control failure with pyrethroids. We have documented revelant levels of resistance among several populations of B. germanica. The phenomenon appears to be widespread.

Even moderate resistance increased KT, especially above the KT-90 level. Increased KT allows survivorship because cockroaches avoid contact with treated surfaces. Some pyrethroids provide a latent effect. However, this effect was not large enough to counteract resistance.

BEHAVIORAL AND CHEMICAL EVIDENCE FOR SEX AND NYMPH DISCRIMINATION BY THE MALE COCKROACH, *NAUPHOETA CINEREA*. Masao Fukui & S. Takahashi (Pesticide Research Institute, Faculty of Agriculture, Kyoto University, Kyoto, 606-01, Japan.)

The possibility of sex and nymph discrimination by mature males was investigated in the cockroach, *Nauphoeta cinerea*. The males show mating (wing-raising) behavior toward mature females after his antennal contact. In contrast, males often behave aggressively toward each other: they bite at each others; wing and/or legs, chase each other and antennate mutually. The males, however, do not show conspecious mating and aggressive behavior toward nearby nymphs. Based on our observation, we concluded that the variability of the male's behavior toward other conspecifics resulted from the male's recognition of adult and nymph.

Pheromones which elicit wing-raising in males were found on body surface from females, while pheromone which elicits aggressive behavior among mature males was found on body surface of only mature males. Also the possible nymph recognition pheromone(s) was isolated from the cuticular wax of nymphs.

We discuss the relationship between the male's behavior and recognition pheromones.

AGGREGATION PHEROMONE OF THE GERMAN COCKROACH: ATTRACTANTS AND ARRESTANTS. Masayuki Sakuma (Pesticide Research Institute, Kyoto University, Japan)

Aggregation pheromone of *Blattella germanica* comprised attractants and arrestants whose activities were evaluated by olfactometer and choice-chamber assay respectively. Both components were extracted with methanol from contaminated filter paper sheets used as shelters. After solvent partition with *n*-butanol and water, arrestants remained in the organic layer whereas attractants were transferred to the aqueous layer. Attractants were treated with ion exchange resin, and eventually identified by GC-MS and the assay on each preparative GC fraction. They were several volatile alkylamines and 1-dimethylamino-2-methyl-2-propanol which formed their salt with acidic components and were evaporating slowly from the source. Arrestants in *n*-butanol were partitioned with acidic and then with basic water. The activity was found only in the neutral fraction. The fraction was subjected to stepwise elution from ODS and then silica gel open column. ODS followed by silica gel HPLC afforded two major components. Spectral analysis including HR-EI-MS, SI-MS, 2D-NMR's with various pulse techniques revealed that their estimated structures were 9-α-chloro-11ξ,12ξ-epoxy-5α-stigmast-3β-yl-β-D-glucopyranoside and 9-α-chloro-11β-hydxroxy-5α-stigmast-3β-yl-β-D-glucopyranoside. Each was denoted as Blattellastanoside A, B respectively.

A METHOD FOR IDENTIFYING LARVAL INSTARS OF THE GERMAN COCKROACH: BRISTLE PATTERNS ON THE TIBIA AND FEMUR. Akira Tanaka (Department of Biology, Nara Women's University, Nara 630, Japan)

In order to identify larval instars, the number of cercal segments (Murray 1967, Tanaka & Hasegawa 1979) has been used for small larvae; and the Mesonotum Index (Tanaka et al. 1986), for large larvae of the German cockroach. The present study shows that bristle patterns on the tibia and femur of the three pairs of legs can be a good index for staging larval instars throughout postembryonic development. The bristles were named by a row-and-level method in the adult stage. Six rows of bristles were recognizable on the tibia, and named as row 1 to row 6. Three rows on the femur were named as row I to row III. Bristles belonging to the same row were alphabetically named as level a, level b and so on from the distal position of the tibia or the femur. The number of bristles per row differed with rows and on the three pairs of legs. In the larval instars, spine-like hairs were found instead of bristles at specific positions of bristles that occur in adults. The number of bristles steadily increased instar by instar until the last instar. Bristles and hairs found on the tibia and femur are also intriguing for studies of pattern formation in developmental biology.

COMBINATION OF MICROENCAPSULATED FENITROTHION AND BORIC ACID FOR COCKROACH CONTROL. Tsutomu Kanzaki, Yoshio Katsuda (Research Laboratory, Dainihon Jochugiku Co. Ltd., Toyonaka, Osaka 561, Japan)

Microencapsulated fenitrothion (fenitrothion MC) was tested in new bait formulations containing boric acid. In the basic efficacy test, bait formulations, incorporating boric acid alone from 15% to 35%, were all slow-acting. In contrast, the combination baits containing 15% boric acid plus 5% fenitrothion MC (1% as fenitrothion) were fast-acting against cockroaches, and this rapid activity was superior to those of single active ingredient formulations of 1% fenitrothion or 5% fenitrothion MC. The combination gave satisfactory kills and also reduced the cockroach population for a long time in field tests.

DISTRIBUTION PATTERNS AND STATISTICS FOR OUTDOOR POPULATIONS OF THE SMOKYBROWN COCKROACH, PERIPLANETA FULIGINOSA. Benson, E.P., A.G. Appel (Department of Entomology, Auburn University, Auburn, Alabama 36849, USA) and P.A. Zungoli (Department of Entomology, Clemson University, Clemson, South Carolina 29634, USA).

Two outdoor populations of the smokybrown cockroach were sampled weekly with jar traps for 3 years. The number of adults by sex and nymphal stage (small, medium and large) was recorded and the cockroaches were released at the site of capture. Traps located in or near harborage sites caught significantly more individuals and a greater proportion of nymphs than traps at other locations. Traps that caught the most cockroaches also had the greatest variance, indicating a clumped spatial distribution. Results of Taylor's power law analysis also imply a clumped distribution pattern. Use of Reusink's sample size equation and the resulting numbers of traps necessary to estimate smokybrown cockroach numbers with various percision levels will be reviewed.

URBAN ENTOMOLOGY IN THE USSR: PROBLEMS AND PERSPECTIVES. Butovsky R.O. (Research Institute for Nature Conservation, Sadki-Znamenskoje, p/o VILR, 113628, Moscow, USSR).

During the last decade the urban entomology became independent branch of entomology in the USSR. The experience of development of urban entomology in the USSR for last 10 years was reviewed. The original data concerning the study of correlation between insect's distribution in human buildings and different factors (types of buildings, social conditions etc.) are discussed. These investigations were carried out by the programme "Ecopolis" in little town Pushino in Moscow region. The horisontal and vertical gradients of changing of densities of synanthropic insects were found. Some social aspects of interrelations of man and different invertebrates on the basis of traditions were determined. The original method of interviewing of urban population using the original questionnaire was developed. The obtained results were compared with those, received by Western scientists.

URBANIZATION AND INTENSIFICATION OF CHIRONOMIDAE NUISANCE: A GLOBAL PERSPECTIVE. Arshad Ali (University of Florida, IFAS, CFREC, 2700 East Celery Avenue, Sanford, FL 32703, USA)

The increasing stress on inland waters in numerous urban situations due to their increased use for a variety of purposes, has created favorable conditions for the development of large populations of Chironomidae. Swarms of adult Chironomidae emerging from such natural or man-made habitats pose a variety of nuisance and economic problems, and in some situations, allergy problems to the nearby inhabitants. Thusfar, ca. 100 species of Chironomidae have attained pest status. Organophosphorus insecticides, such as chlorpyrifos, temephos and others in the USA, France, Italy and Japan have provided larval control for 2-5 weeks or longer at application rates of <0.56 kg AI/ha. Frequent use of OP insecticides in some situations in USA and Japan has resulted in an increased tolerance of these insecticides by several chironomid species. Alternatively, insect growth regulators (IGRs), such as diflubenzuron and methoprene, in many situations have suppressed >90% adult midge emergence when used at rates <0.3 Kg AI/ha. A number of pathogens and parasites of chironomids has been reported from different parts of the world. *Bacillus thuringiensis* serovar. *israelensis* is effective against some chironomid species but at rates at least 10x or higher than those employed as mosquito larvicides. The flatworm, *Dugesia dorotocephala*, and some fish species offer a potential for midge control in some habitats. The larval ecology of nuisance chironomidae is poorly understood at present.

A REVIEW OF WOOD BORERS IN TIMBER STRUCTURES IN AUSTRALIA AND THEIR CONTROL. J.W. Creffield (CSIRO Division of Forest Products, Clayton, Victoria 3168, Australia)

A review of the more common wood borers which infest timber structures in Australia is given. Most of the wood borers encountered are pests of seasoned timbers. However, certain species which initiate attack in the native forest tree and complete their life cycle and emerge from sawn timber when in-service after it has dried, are also discussed. Other borers are able to survive only in timber which is actively decaying by wood-rotting fungi. Current preventative and remedial control measures for all wood borers listed are presented.

RETICULITERMES SPP. AS STRUCTURAL PESTS. Deborah A. Waller (Biology Department, Old Dominion Univ., Norfolk, VA 23529 USA)

Reticulitermes (Isoptera; Rhinotermitidae) is a serious structural pest throughout temperate regions. The distribution and ecology of different Reticulitermes species is reviewed along with their pest status. Species differences between major economic pests and those that are less damaging are discussed. The effectiveness of different control measures is evaluated in light of current information about Reticulitermes biology.

INTEGRATED PEST MANAGEMENT FOR THE SUBTERRANEAN TERMITES. Nan-Yao Su (Ft. Lauderdale Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, Ft. Lauderdale, Florida, USA 33314)

Structural environments which harbor termite infestations differ greatly while soil treatments, fumigation, and spot treatment are the only techniques available in termite control. Due to the enormous success of soil termiticides and their widespread use, termite control industry is outfitted to deal with the target pests in a complex environment with few control alternatives.

A successful IPM program for termite control demands our understanding of natural factors regulating termite populations, and our ability to enhance/supplement these factors to affect the populations.

In addition to practical monitoring tools, physical exclusion devices such as sized particle barriers and baiting programs using slow-acting toxicants will play vital roles in the IPM programs for subterranean termite control in the near future.

EVALUATION OF SOIL TERMITICIDES IN THE UNITED STATES. Bradford M. Kard, Susan C. Jones, Joe K. Mauldin (USDA Forest Service, Gulfport, Mississippi, USA)

For several years, organophosphate and pyrethroid termiticides have been field-tested as treatments to soil for prevention and control of subterranean termites. Following a 1.5- to 2-year laboratory screening program consisting of a series of termiticide-treated soil bioassays, the most effective contact toxicants to termites are then installed in field tests. The following currently marketed termiticides were placed in USA nationwide field tests during certain years from 1971 through 1980: chlorpyrifos, isofenphos, cypermethrin, permethrin, and fenvalerate. Test sites represent subtropical, temperate, and arid climates. *Reticulitermes* spp. predominate in the subtropical and temperate climates, whereas *Heterotermes aureus* is the main arid climate pest. The ground-board and concrete slab test methods were used to evaluate the termiticides. Generally, organophosphates provided 6 to 12 years of 100% control, and pyrethroids provided 1 to 13+ years of 100% control, of subterranean termites when applied at lowest label rates.

EVALUATION OF TERMITICIDES USED IN PEST MANAGEMENT PROGRAMS R.E. Gold, Urban Entomology, Texas A&M University, College Station, TX, USA

Test sites have been established in five locations in Texas to evaluate nine commercial termiticides including: bifenthrin (Biflex); chlorpyrifos (Dursban TC); cypermethrin (Demon and Prevail); fenvalerate (Tribute and Tribute II); isofenphos (Pryfon 6); and permethrin (Dragnet and Torpedo). Efficacy of each product has been evaluated in terms of protection of wooden stakes in treated soils and pesticide residues analyzed with gas chromatography. Soil samples were taken at time 0 and then at 1, 6, and 12 months post application. Soils from the five sites varied in soil series (Austin silty clay to Libert loamy fine sand); pH (6.39 to 8.16); organic content (3.92 to 0.83%) and conductivity (0.05 to 0.35 dS/m). Termiticide degradation was significant for all products within the first 12 months of the study.

TERMITE CONTROL USING PHYSICAL BARRIERS AND BAITING TECHNIQUES. J.R.J. French and B. Ahmed (CSIRO Division of Forest Products, Private Bag 10, Clayton, Victoria 3168, Australia)

Environmental concern for the continued use of organochlorine termiticides around the world, particularly as soil chemical barriers, has led to a re-appraisal of termite physical barriers. However, there is no such thing as a barrier that is totally secure. Thus, in the event of such barriers being penetrated, the use of suitable bait systems and bait toxicants is considered an integral component of any future termite control strategy. Such a system is environmentally friendly, has wide public acceptance, and marketable. But more emphasis needs to be given to "building out termites", and suggestions for this approach, and where such systems can be incorporated into local building codes of practice, are presented.

WOOD PRESERVATIVES FOR PROTECTION AGAINST FORMOSAN SUBTERRANEAN TERMITES (ISOPTERA: RHINOTERMITIDAE). J. Kenneth Grace (Department of Entomology, 3050 Maile Way, University of Hawaii, Honolulu, HI 96822-2271, USA)

Wood can be protected from termite and fungal attack by pressure impregnation of new wood with preservative chemicals, or by the application of diffusible preservatives to the surface of wood in use. Although wood preservatives must be toxic to decay fungi, preservative applications may render wood either poisonous or unpalatable to termites. In Hawaii and other tropical regions, termites are a greater problem in structural timbers and utility poles than are decay fungi. Preservatives recently evaluated for efficacy against the Formosan subterranean termite, *Coptotermes formosanus* Shiraki, include several different formulations of chlorothalonil, copper naphthenate, and disodium octaborate tetrahydrate. In laboratory tests, chlorothalonil retentions of 3.2 kg/m3 reduced *C. formosanus* feeding on pine, while 6.4 kg/m3 resulted in ca 80% termite mortality and less than 10% weight loss from the treated wood. In field tests, 3.8 kg/m3 disodium octaborate tetrahydrate reduced termite feeding on Douglas-fir to superficial levels (ca 2.5% weight loss). Water-based and ethylene glycol-based borate formulations have also been evaluated as remedial treatments.

Comparison of Methods for Detecting Termites Within Structures

Vernard R. Lewis, Department of Entomology, University of California, Berkeley, California 94720 USA

The first step in termite control is accurate detection. Regardless of the termite control method used, if you can neither idenfity your target pest nor define the extent of the infestation, your control remedy will be less effective.

Though research on termite control shows promise for the development of non-chemical alternatives, physical barriers, and baits, little has been done for improving inspections. The use of electronic odor detectors, electronic stethoscopes, and termite-seeking dogs are gaining in popularity, though their usefulness has not yet been rigorously tested.

In today's presentation, I will review laboratory studies on the termite detection capabilities of odor detectors, dogs, and acoustical devices.

PENETRATION AND PERMANENCE OF INSECTICIDES APPLIED TO OR INJECTED INTO STRUCTURAL TIMBER. William H Robinson (Urban Pest Control Research Center, VPI&SU, Blacksburg, VA 24061 USA)

A variety of insects infest and cause serious damage to structural timber around the world. Controlling wood-infesting insects involves the use of fumigation, or the application of liquid insecticides to the outer surface or injected below the surface of infested wood. Penetration and permanence of liquid insecticides applied to wood depends of the species of wood, the formulation, the method of application, and the environment. In general, water and oil dilutions of organophosphate and pyrethroid insecticides penetrate only the outer 3 mm of wood. Residues of chlorpyrifos and permethrin at the surface of southern yellow pine (Pinus sp.) are depleted within 6 months following application when stored in household environments. When measured at 24 h there was a significantly greater amount of chlorpyrifos at the surface (50 mm) of five softwood species treated with water-based emulsions than with oil-based emulsions of 1% chlorpyrifos. There was no significant difference between oil and water dilutions in the amount of 1% chlorpyrifos delivered to 25 mm depth in the five softwood species (Japanese cedar, western hemlock, cypress, Japanese red pine, and southern yellow pine)

ECONOMIC IMPORTANT TERMITE SPECIES IN CHINA. Daorong Gao (Nanjing Institute of Termite Control, Nanjing 210002, China), Paul K.S. Lam (Department of Biology, Chinese University of Hong Kong, Hong Kong), Yagab Sheik ("ASIA" Pest Control Limited, Hong Kong).

Termite are important pests which can cause serious economic losses. They can damage the structure of houses, trees, horticultural crops, river banks, reservoir dams and underground cables, as well as transmission posts. Of the 379 termites species in China, 70 were found to attack structures and wood products. Termites capable of causing such damage include Coptotermes (southern China), Reticulitermes (northern China and regions along Yangtze River), and Cryptotermes (southern China). Glyptotermes, Odontotermes, Marcrotermes, Hodotermopsis, Ancistrotermes, Microcerotermes, Nasutitermes and Xiaitermes are serious hazards to simple houses built close to forests on hillsides and timbering. Damage caused Incisitermes has also been recorded in coastal regions of eastern China. Species of the genus Coptotermes are often considered as most destructive chiefly because of their great dispersal power, large colony size and high speed of destruction. Reticulitermes is particularly important due to its wide distribution.

DISTRIBUTION OF TERMITE IN CHINA. Daorong Gao (Nanjing Institute of Termite Control, Nanjing 210002. China), Stephen Ip (Pesticide Service Co. Ltd., Hong Kong), Romeo L. Dizon (Velsicol Chemical Corporation, IL 60018-5119, USA)

China has a very rich isopteran fauna, with abundance and diversity from north to south. Termites are found throughout the country except Xinjiang, Neimenggu, Ningxia, Qinghai, Jilin and Heilongjiang, ranging from Dandong (Liaoning Prov., 40.1 N) in North to Hainan Prov. and Xisha Islands in the south. To date (1987), 379 species and 2 subspecies of termites are known to occur in China. The termite fauna in China is separately belong in the Oriental Region and the Palaearctic Region. Their boundaries, in the western is the large belt caused the Yangtze Plate impacted with the North China Plate (this bound-line starts with Qingchuan in the northern of Sichuan Prov., and crosses over Shaanxi and Henan). and in the eastern is the Huai He River. The termites in the Palaearctic Region in China is only presenting the Genus Reticulitermes. The Oriental Region distributed termites in China can be divided into three subregions roughly: 1) The Mid- and East China Subregion. In this area, Reticulitermes spp. and Odontotermes spp. are the wide distributed species. 2) The South China Subregion. Coptotermes spp. are dominant species there and also there are special Cryptotermes spp. 3) The Indo-Malaya Subregion. There are certain special genera from Indo-Malaya subregion, e. g. Parrhinotermes, Mirocapritermes, Hypotermes, Ancistrotermes, Bulbitermes and Hospitalitermes etc.

SCANNING ELECTRON MICROSCOPIC STUDIES ON WING MICROSCULPTURING IN THREE SPECIES OF KALOTERMITIDAE (ISOPTERA). Zhang Fangyao, Tang Jue, Li Shen (Department of Plant Protection, Zhejing Agricultural University, Hangzhou, Zhejiang 310029, China)

The wing microsculpturing in three species of Kalotermitidae: Cryptotermes delivis Tsai et Chen, C. pingyangensis He et Xia, Incisitermes laterangularis Hang, was studied by using Scanning Electron Microscope (SEC). Large papillae, with apex directed vertically, were found on the wing surfaces of these three termites species. The size of the base of the papillae was 16.4- 32.3, 17.9-58.6, and 15.6-40.2 μm respectively. The density of the papillae at the middle part of the wing surface was ca. 467, 282 and 349/mm^2 respectively. Each vein of these three termites consisted of relative smaller papillae. The papillae distributed over the whole wing surface. There was no difference between the fore- and hind-wing. From the shape and the arrangement of the papillae, it is easy to distinguish these three termites. The possible significance of the occurance of the papillae in termite wings was discussed briefly.

PURINE METABOLISM IN *NASUTITERMES WALKERI:* URATE SYNTHESIS AND SALVAGE PATHWAYS. D.J. Chappell and M. Slaytor (Department of Biochemistry, The University of Sydney, Sydney, N.S.W. 2006, Australia)

Purine interconversions leading to urate synthesis were studied using the incorporation of radioactive compounds and by direct enzyme assay. Isolated fat bodies from freshly collected *Nasutitermes walkeri* incorporated radioactivity from ^{14}C-hypoxanthine (1.3%), ^{14}C-inosine (0.3%) and ^{14}C-guanosine (37%) into urate while only ^{14}C-guanosine (3%) was salvaged to nucleotides. These results indicated the presence of the enzymes nucleoside phosphorylase, xanthine dehydrogenase, guanase and that neither inosine nor hypoxanthine could be salvaged. Assay of termite extracts confirmed the absence of hypoxanthine-guanine phosphoribosyltransferase (HGPRT) and inosine kinase indicating that the synthesis of inosine is the committed step in the catabolism of IMP and AMP to urate. Adenine phosphoribosyltransferase (APRT) (0.277 ± 0.014 nmol/min/mg protein), 5'-nucleotidase and adenosine deaminase were also detected and in addition a low activity of adenosine kinase (0.025 ± 0.002 nmol/min/mg protein) was present and may be required to prevent depletion of the adenylate pool. The inability of *N. walkeri* to salvage inosine and hypoxanthine suggests a mechanism for the apparently uncontrolled synthesis of urate, by termites, during laboratory storage. The activity of nucleoside phosphorylase, which is extremely low in freshly collected termites, increases in activity concurrently with uric acid synthesis after collection. In the absence of the usual salvage pathway, this enzyme may control the flux of purines to uric acid, through product inhibition of 5'-nucleotidase, and in consequence control the rate of *de novo* synthesis.

CELLULOSE DIGESTION IN TERMITES: DO SYMBIONTS PLAY A ROLE? M. Slaytor (Department of Biochemistry, The University of Sydney, Sydney, N.S.W. 2006, Australia)

Biologists are familiar with the presence of cellulolytic protozoa in the hindgut of lower termites but are less familiar with the absence of these protozoa from the higher termites which make up 75% of all termite species. All termites have a large variety of bacterial morphotypes in their hindguts but there has been no clear demonstration that any of these are cellulolytic. We have clearly demonstrated the presence of endogenous endo-β-1,4-glucanase and β-1,4-glucosidase in species belonging to the subfamilies Coptotermitinae, Nasutitermitinae, and Macrotermitinae. Further these activities produce glucose from crystalline cellulose at rates comparable to metabolic requirements as measured by O_2 utilisation and CO_2 production: they are also restricted to the foregut and anterior midgut, regions which are largely devoid of microorganisms. Biochemically, the localisation of endogenous cellulase in the foregut and midgut ensures that the termite will have access to glucose by absorption through the midgut. We believe that there is no evidence that the protozoa in the lower termites and the cellulolytic fungi cultivated by the Macrotermitinae are necessary for the hydrolysis of cellulose and that all termites produce endogenous cellulase for this purpose.

XVC-1 Management of Stored Product and Structure Insects

A STUDY ON THE TOXIC EFFECTS OF NINE CHINESE MEDICINAL HERBS ON THE STORED GRAIN INSECTS. Yong-jia Jiang, Yi-jin Yan (Zhengzhou Grain College, Zhengzhou 450052, China)

A study on the toxic effects of nine chinese medicinal herbs Paeonia suffruticosa Andr., Cnidium monnieri(L.) Cuss., Zanthoxylum bungeanum Maxim., Curcuma longa auct. non L., Elsholtozia stauntonii Benth, Melia azedarach L., Areca catechu L., Pinellia ternata Breit, Prunus mume Sieb. et Zucc., etc. against maize weevil, lesser grain borer, confused flour beetle, red flour beetle and chinese cowpea weevil by topical applications, spraying and fumigating was described. The results showed that seed oil of M. azedarach, volatile oil of E. stauntonii and hot ether extractof P. suffruticosa exhibited distinct contact toxicity; 95% hot ethanol extract of C. monnieri exhibited certain contact poison as well. The volatile oil of E. stauntonii has also strong fumigating toxicity. The treatment of different stages of red flour beetle with seed oil of M. azedarach mixed with diet led to morphological distoration of different stages. Butanol extract of A. catechu has certain inhibiting effect on the midgut amylase activity of confused flour beetle larvae.

EXPERIMENTS ON THE POSSIBILITY OF PESTS CONTROL IN BULK-STORED MAIZE AND RICE WITH TRAP DETECTOR. Wei Yao (Shaanxi Institute of zoology, Xian 710032, China)

The paper reports the effects of the controlling stored grain insects in bulk-stored maize and rice with trap detector for three times every 24h. The results showed the quantities of the 3rd detection were reduced by 84.2%, 100%, 70.7% and 27.5% respectively than that of the 1st detection on fix places about the average capture of *Sitophilus zeamais, Typhaea stercorea, Sitotroga cerealella* and *Microbracon hebetor* in the bulk-stored maize. The average captures of *S. zeamais, Enicnomus minutus, C. ferrugineus, Oryzaephilus surinamensis, Troctes divinatorius* and *Tyrophagus putrescentiae* during the 3rd detection in the bulk stored rice were reduced by 57.9%, 60.5%, 100%, 83.3%, 98.5% and 98.6% respectively than that of the 1st detection.

STUDIES ON FUMIGATION TECHNOLOGY OF ALUMMINIUM PHOSPHATE TO CORN IN BULK IN SAILING SHIP. Zhi-nong Mao (Animal and Plant Quarantine Station of Dalian 116021, China.)

The method we use was rather simple and feasible to apply fumigation to corns in bulk. With a good chemical residue retrieving, corns were free from pollution efficiently. Chemical residue in corn was much lower than safe standard stipulated by FAO and WHO. Adults of Stiophilus zeamais and last instar larvae of Trogoerma rariabile were used in the experiment. By applying different amount to different layers and spots, sufficient density of poision gas could reach in cargo hold with sufficient sealed time to assure a good effect. At present, the combine fumigation method is a new and efficient one in less than 30000 tonnage oceangoing ships with well-distributing and good effect whether in sailing or in anchor spot.

SEWAGE GAS KILLS INJURIOUS INSECTS IN THE GRAIN RESERVES. Zhuanghua Xu (Jiangxi Grain School, Jiangxi Province 330100, China)

There is a low content of O_2 in the sewage gas, accounting for 0.5% of its total. The injurious insects can be suffocated to death in this anoxia. However, sewage gas can be filled into the airtight grain reserves by using the several methods: excluding mixture of air and sewage gas in short time, filling in the sewage gas for a long time, filtering and directly filling. To fill the sewage gas into the airtight grain reserves to dissolute an exclude the air, when the sensity of O_2 in the airtight grain reserves is decreased to less than 5%, and the density of CO_2 is increased to more than 20% all kinds of pests on the surface of the grain can be killed after 5 days. When the density of O_2 is decreased to less than 2%, and the density of CO_2 is increased to 29%, all kinds of pests in grain can be killed after 15 days. The sewage gas pool with volume of about 20-50m^3, can supply the required amount of sewage gas to kill the pests in the small barn in the capacity of about 100,000 to 250,000kg of grain. The farmers' household pool with volume of about 8-10m^3 can deal with 1,000 to 3,000 kg of grain per day. It is provided the character such as non-impairment of grain quality, non-pollution of the gain and non-occurance of fire and explosion, as well as gas poisoning.

RELATIVE RESISTANCE OF ROUGH RICE, MILLED RICE, BROWN RICE TO THE MAIZE WEEVIL (SITOPHILUS ZEAMAIS MOTSCHULSKY) DURING STORAGE. Hong-yu Zhang, Wan-shie Dung (Department of Plant Protection, HuaZhong Agricultural University, WuHan 430070, China)

In this sutdy, chose 4 resistant varieties and 2 susceptible germplasms on the basis of screening rice varieties, studied resistant difference of rough rice, milled rice and brown rice. 18 samples were free infested for 7 days with 500 adults, all of which were 7-14 days old, at 27-30℃ and 80% RH. Fuzzy cluster analysis was used for synthetically evaluating the resistance of 18 samples. The result showed: 6 brown rices were the most susceptible, 4 rough rices of the resistant, germplasms were the most resistant, the others were intermsately resistant, and not significantly different at the 5% level by Duncan's multiple range test. Also, the study confirmed the importance of the husk in providing rice resistance to the maize weevil and showed that the resistance of resistant varieties lost while rough rice was processed into brown rice. So, cosidering to control storage pest, we should fristly store rough rice of the resistant germplasins. It was not suitable to store brown rice.

AN INVESTIGATION ON THE CONTROL OF STORED GRAIN MITES Zheng Wei (Jiangxi Cereals & Oils Storage and transporation Co, Nanchang 330046, China)

In grain storage, the infestation of stored grain mites is very universal. It is widely distributed in all parts of the world. The mites are troublesome in grains of 15% moisture content and 70% relation humidity. When the mites present in large numbers, it is an indication that moisture content in grain and cerealproduct is high.

Owing to the small size, numerous species, wide distribution, complex feeding and great vitality, its breeding speed is very fast. It is not only the great vitality, but also more tolerance to insecticides, especially the inactive stage as egg and dormant body. Several control methods, such as simple insecticides, complex insecticides, mixed control and bioecology synthetical control are described. These methods appeared easy, low costs and good efficacy. The effective means and technology for the stored grain mites control were discussed.

A SURVEY ON TIBET STORED PRODUCT MITE FAUNA. Xiang-lin Shen
(Department of Grain and Oil Storage, Zhengzhou Grain College, No. 140 Songshan Road,Zhengzhou 450052, Henan, China)

It is reported that the first survey on species and distribution and damage of stored product mites in Tibet from June to August, 1987. In this survey, the author discovered 39 species of stored product mites, including 9 new-record species and 16 damage several species, respectively. It is notice first that stored product mites respectively. It is notice first that stored product mites species existed in place with an elevation of 1700—4200 metre similar to the interior of our country, but these mites have been turned into a specific strain which can survive at cold hardness in dry atmosphere with less oxygen.

HOW TO ELIMINATE THE ANTS WHICH JEOPARDIZE THE BUILDINGS. Xiang-hua Kong
(South China Normal University,Guangzhou 510631, China)

Some kinds of ants are germ carriers. When they are crawling inside the buildings, stealing some food, snapping persons or attacking the economic animals raised by people, they injure people, make people infected with disease or cause great economic loses. To eliminate the ants inside the buildings, the ways can be used as following: A.Biological way, we can use chicken, pangolin or other animals to eat up the ants which they meet as well as the ants inside the ant-nest. B.Physical way, when we find the ants, whatever inside or outside the ant-nest, we can use fire to burn them, or use boiled-water to scald them. C.Chemical way, we can use the insecticides such as Mirex , dichlorvos chlordane etc. to kill the ants that we find. D.Trapping way, to lure the ants to a certain place by putting ants' favourite food there, then kill them with the biological, physical or chemical way. E. In order to eliminate the ants, we can also use ants' favourite food with insecticide Fungusproofing agents etc. as bait, or as compounds of different shapes of ant-kill-medicine. And then we place them at the spot where the ants get together, or put them beside the ant-nest. After the ants have eaten such kinds of food, they would be infected with each other, get poisoned and die. F.The way of using pheromone, we can use ants' trail-following pheromone(or something likes that) to lure ants and kill them. G.The way of using hormone, we can also use ants' juvenile hormone(or something likes that) mixed with bait to lure the ants to eat the food, making them died completely.

XVC-2 Development of Environmental Impact in Stored Product and Urban Insects

THE SPECIES OF STORED GRAIN INSECTS IN URBAN DISTRICTS AND THEIR CONTROL IN CHINA. Qi-zong Chen(Zhengzhou Grain College, Zhengzhou 450052, China)

Stored grain insects are a part of urban pests, 43 species of stored grain insects can generally be found in China and of these 13 species are most important. They are distributed in grain warehouses, in flour and rice mills and cereal food processing manufacturers, in grain retail shops, in warehouse at ports and in families. Sometimes quarantine insect pests, such as granary weevil, khapra beetle, are discovered and caught by inspectors in port.

The effective method of controlling pests, based on the principle of safety to the people's health, economy in cost and high effectiveness, is a comprehensive system of integrated control with stress on prevetion, i. e. in all links from grain storage, processing, transporting down to finished product storage and sales. Various technical measures must be taken, including quarantine control, environmental hygiene, good management, temperature control, atmosphere control, control by natural habits, mechanical clearing, chemical control and so on. In order to obtain satisfactory results all these measures must be taken in mutual coordination.

A STUDY OF THE BIOLOGY OF THE INDIAN MEAL MOTH PLODIA INTERPUNCTELLA (HUBNER). E-ting Zhu (Grain Storage Research Department, Grain Research Institute of Zhejiang Province, Hangzhou 310012, China) , Jue Tang (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

Plodia interpunctella is one of the most important early stored products pest. Studies on the biology of the moth were carried out in Hangzhou, Zhejing Province during 1987 to 1989. Plodia interpunctella has three to five (mainly four) generations a year in Hangzhou and generally begins to hibernate in late October as a full-fed larva in the cocoon. Generations overlap. Adults were present from early May to November. The developing durations of the 2nd and the 3rd generations (44.17 and 48.61 days, respectively) were shorter. Their intrinsic rates of increase (0. 11231 and 0.12119, respectively) were higher and their population increased faster than that of the late generations. The duration (259. 43 days) was the longest for the hibernation generation. Adults could live about a week and the number of eggs laid per female averaged about 200. The hatching and emergence rates were higher than 90% and the survial rates during the larval stage were about 80-90% for all generations. The habits of adults and larvae were described in detail.

A STUDY OF THE BIOCLIMATIC RESPONSES OF THE INDIAN MEAL MOTH PLODIA INTERPUNCTELLA (HÜBNER). E-ting Zhu (Grain Storage Research Department, Grain Research Institute of Zhejiang Province, Hangzhou 310012, China), Jue Tang (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

The combined effects of temperature, relative humidity and larval density on the development rate, survival rate and fecundity of Plodia interpunctella were studied by experiments of regression rotational combinational design. The observed data under 15 combination conditions of temperature, relative humidity and larval density were listed. Models on the relationships between development rate, survival rate or fecundity and temperature, relative humidity or larval density were developed.

STUDIES ON THE BIOLOGY AND DISTRIBUTION OF STORED PRODUCTS CUCUJIDAE IN CHINA. Baogeng Sun, Lizheng Chen (Sichuan Grain Storage Research Institute, Ministry of Commerce, Chengdu 610031, China)

Cryptolestes pusillodides occur commonly in most stored products. C. pusillodides may develops at a temperature range of 15-35℃ at 50-90% R. H. Development of the insect is rapidest. When 33℃, 90% RH it takes about 23 days. Rates of oviposition and hatching are hightest, when 30℃, 90% R. H. . Life history of C. pusillodides is very similar to Cryptolestes ugandae. This paper described studies of the morphology, biology and distribution of four species of Cucujidae.

THE STORED PRODUCT PESTS OF DERMESTIDAE IN SHAANXI. Zhi-dan Cao (Shaanxi Institute of Cercals and Oils, Xian 710082, China)

There are near 100 species of Dermestidae in China. Most species are stored product pests. There are 16 species and 5 subspecies in shaanxi, and a catalogue of all known species is following:

1.Dermestinae Linnaeus, 1758

Dermestes ater Degeer, 1774; *Dermestes coarctatus* Harold, 1877; *Dermestes fasciventris* Reitter, 1881; *Dermestes laniatius* Illiger, 1801; *Dermestes maculatus* Degeer, 1774; *Dermestes shaanxiensis* Cao, 1987; *Dermestes tessellatocollis* Motschulsky, 1860; *Dermestes tessellatocollis pici* Mroczkowski, 1963.

2.Attageninnae Castelnan, 1840

Attagenus augustatus gobicola Frivaldszky, 1892; *Attagenus brunneus* Faldermann, 1835; *Attagenus unicolor japonicus* Reitter, 1877.

3.Megatominae Leach, 1815

Trogoderma glabrum (Herbst, 1783); *Trogoderma teukton* Beal, 1956; *Trogoderma variabile* Ballion, 1878; *Thaumaglossa ovvivora* (Matsumura et Yokoyama, 1928).

4.Anthreninae LeConye, 1861

Anthrenus flavidus Solskij, 1876; *Anthrenus picturatus hintoni* Mroczkowski, 1952; *Anthrenus verbasci* (Linnaeus, 1767) ; *Anthrenus pimpinellae latufasciatus* Reitter, 1892.

5.Thylodriadinae Mroczkowski, 1954

Thylodrias ccontractus Motschulsky, 1839.

6.Thaumaphrastinae Anderson, 1949

Thorictodes heydeni Reitter, 1875.

A STUDY ON REGIONAL DISTRIBUTION OF PESTS INJURING THE ARCHIVES IN CHINA. Bing-zhong Zhao (Archives Office, Xian Jiaotong Univ., Xian 710048, China)

The species, distributions, destructions, habits and characters of reproduction and development of the pests injuring archives were studied, 403 places in 26 provinces were investigated, 30 species of the insest pests (7 familes 19 species of Coleoptera, 1 family 4 species of Isoptera, 2 familes 5 species of Biattariae, 1 family 1 species of Thysanura and 1 family 1 species of Psocoptera) were recorded from 1960's to 1980's in China.

These pests are distributed widely in China. 10 species are world-wide, 15 species are regional, 5 species are peculiar to China, in which *Gibbium psylloes* Gzempinski is distributed discontinuously.

According to the distribution of *Falsogastrallus sauteri* Pic. and *Coptotermes formosanus* Shiraki, the North of Qin Mountains and Huai River is defined as Palearcpac Realm, and the South of Qinling Mountains and Huai River is Oriental Realm. Palearcpac Realm is divided into 5 regions: the North-East, Nei Monggol, Qing hai-Xizang, Xingjiang, north China. In the first 4 regions the species of insects are fewer, density less, and active time shorter, so the insects do not do seriors destruction to archives. In north China, kinds of the insects are more, but density less, so the destruction to archives lower also. Oraental Realm is divided into 2 regions: Middle China, South China. In these two regions the kinds of insects are fewer, but their densities very greater, especially over the two regions the kinds of insects injuring to archives are all distributed, so the destruction is more serious than that in Palearcpac Realm.

THE COMMUNITY COMPOSITION AND STRUCTURE ANALYSIS OF INSECTS IN BULK-STORED WHEAT. Wei Yao (Shaaxi Institute of zoology, Xian 710032, China)

The 42 samples of wheat were tested with trap detectors at the depth of 5.5-31.5cm, 57-83cm, 108-134cm and 160-186cm respectively and it was a day's records from 7:00-12:00, 13:00-18:00, 19:00-24:00 and 1:00-6:00 separately. The results indicated that there were 13 species stored product insects, the dominant species was *Sitophilus zeamais*, it represented 87.5% in amount of insects captured. The accessory species were *Sitotroga cerealella, Troctes divinatorius, Tyrophagus putrescentiae* and *Microbracon hebetor*. The studies obtained the dynamic characteristic of insect community in the diel cycle, the vertical distribution and the interspecific association of stored product insects. The evenness (J') and diversity indice (H') were measured based on the diversity indice models by Shannon-Wiener (1949).

STUDIED ON BIONOMICS OF PECTINATE-HORNED ANOBIID (PTILINEURUS MARMORATUS REITTER). Zhi-hui Yang, Wan-shie Dung, Hong-yu Zhang, Shan-qian Hu (Department of plant proteciton, HuaZhong Agricultural University, WuHan 430070, China)

Pectinate-horned anobiid is an important pest of ramie (Boehmeria nivea) during storage. In this paper, by barn investigation and laboratory observation, studied on bionomics of pectinate-horned anobiid. The results can be summarized as follows: It has one generation per year, and overwinters in the larval stage in WuHan. Overwintered larvae haven't diapause, and begin to active in early April. The larval mortality is 21% in overwinter stage. The number of days for pupa is 6 to 8. In middle May the adults begin to appear, and most emergence of the adults usually take place from late May. The adults are very active, they need not complement nutrition, and begin to pair after emergence. Oviposition begins 2 days after pairing and the peak lies on the 3th to 5th, the total number of eggs laid per female is about 60 to 80 in average, she may lay more than 160 eggs under favorable conditions. The eggs hetch after 7 to 9 days. The adults live 12 to 16 days.

The best way to control this pest is to prevent them from becoming established in the barn, in winter barn should be cleaned enough to destroy overwintered larvae and fumigation in peak stage of the adults emergence.

STUDY ON THE WAREHOUSE PESTS RICE WEEVIL AND MAIZE WEEVIL. Zhi-yuann Yang (Jiangxi Grain and Edible Oil Research Institute, Nanchang 330029, China)

The rice weevil (Sitophilus oryzae Linnaeus) and maize weevil (S. zeamais Motschulsky) are important warehouse pests and very similar to each other in appearance. This papee presents the results obtained from the comprehensive studies on them. Through the comprehensive studies, the identity and difference between them are found in the interior structures and appearance, life habits, distribution, band of Esterae Isoenzyme, sperm ultrastructural organization, karyotype, and resistance to phospine, and so on. According to the results that a certain rate (3% or so) of reproductive hybrid progenies can be produced after the crossing between them, and to the studies on the reproduction ability, physiology and biochemistry of the hybrids, we put forward the new idea that they had close relationship and didn't differentiate into two fully different species for they didn't complete the process of reproductive isolation.

THE CAUSES OF THE TERMITE HARM TO THE NEWLY BUILT REINFORCED CONCRETE STRUCTURE BUILDINGS. Xiang-hua Kong (South China Normal University, Guangzhou 510631, China)

Some large buildings of reinforced concrete structure, soon after they have been built, will be found harmed by the termite, the main causes are following: A. The time of the capital construction of these large buildings was long while about two months in every year are the colonizing flight time of the termite. B. Building site is often constructed in the evening. While the lights are just luring the breeding termite to fly there, and to settle down. C. Modern buildings (especially in the city) have destroyed the ecological environment of the termite's natural enemies and reduced their population. It increases the termite's reproduction coefficient. D. When the capital construction is under going, water resources are plentiful and gloomy spots are everywhere, termite's reproduction is improved. E. The roots of trees, timber and the materials which contain cellulose are scattered in the construction site. Because timber and fibrous things are everywhere and the dark conners and the mould boards of the expansion joints could not be demolished, all these supply enough food for the termite. F. The termite has not been eliminated from around the buildings or the underground of them. G. It is damp, gloomy, and badly ventilated between all kinds of decorating materials, such as fibreboard, plasticboard, foamboard, carpet, the wall, the ceiling and the floor. So, an ideal living environment has been provided for the termite.

A STUDY ON THE CHANGES OF ECOLOGICAL FACTORS AND STORED GRAIN INSECTS POPULATION DYNAMICS IN GRAIN MASS ECO-SYSTEM Li Guang-can, Qin Zong-lin, Zhang Qing-cun, Hou Xin-wei (Chengdu Grain Storage Research Institute, Ministry of Commerce, Chengdu 610031, China)

In field storage, the temperatures of air, warehouse and grain mass reflect the change of seasons. The general pattern is: the temperature of grain and warehouse goes up and down as the air temperature does the three temperatures. For the different layers (upper, middle and bottom) of the grain mass, the lower the layer is the steadier the temperature is. The temperature in the centre of grain mass is much steadier than that of the rim and is not easy to be affected by ambient temperature. Grain moisture content in grain mass is very steady, with only little changes, and it is steadier at lower layers. The change of oxygen in upper, middle, bottom layer is little, this change has not much influence to the increase of stored grain insect population.

Under the natural and normal storage conditions, maize wiveel is found to be the dominant pest in stored wheat. Its density reaches 70 heads per kilogram. The changes of insect population and species in stored grains are influenced by grain temperature greatly. Stored grain insects have the characteristic of assembling to the surface of the grain mass. The relation between surface insect population density and the space density appears to be direct ratio.

HOST STATUS OF LYCHEE TO *BACTROERA TRYONI*(Froggatt) (*DIPTERA: TEPHRITIDAE*) IN EASTERN AUSTRALIA. Zhi Tang (Visiting Entomologist from Plant Quarantine Institute, Beijing 100026, China), N.W.Heather (Entomology Branch, QDPI, Indooroopilly 4068, Australia)

"Tai So", the dominant lychee cultivar in Australia was shown, through field and laboratory studies, to be a very low susceptibility host of Queensland fruit fly up to and including the stage of commercial maturity. The tough exocarp mostly prevented flies from ovipositing, although in cages in the laboratory oviposition happened occasionally in undamaged fruits around the stalk attachment area. Egg mortality>98% in the aril and larval mortality of 60-70% further reduced susceptibility. Oviposition was induced successfully through artificially damaged skin or natural surface damage under high fly densities both in laboratory cages and caged fruit on the tree. Adult flies reared from field samples of blemished fruit showed the possibility of natural infestation following damage including physical cracks, mechanical injury and pest damage of fungal infection. These possibilities of lychee incurring fruit fly infestation, although a very low risk, can be expected to make it necessary to develop quarantine disinfestion schedules for trade within Australia and overseas.

INSECT PESTS AND CONTROL ON HISTORICAL RELICS. Sen Zhao, Shao-jun Yang(Tianjin Animal and Plant Quarantine Service, Tianjin 300456, China)

China is a great nation with long history and excellent culture. She possesses many sites of ancient cultural remains.

The relic of wood, bamboo, silk, flax, cotton, paper etc. are frequently attacked by insect pests, such as *Lyctidae*, *Dermestidae*, *Anobiidae*, *Scolytidae*, *Cerambycidae*, *Buprestidae*, *Isoptera*, *Liposcelidae*, *Lepismatidae*, etc. We should carry out the policy of putting prevention first, and sometimes the method of fumigation is requisite. The Vikane(SO_2F_2) is a good fumigant.

PRELIMINARY STUDIES ON THE GAMMA IRRADIATION AS A QUARANTINE TREATMENT TO KHAPRA BEETLE, *TROGODERMA GRANARIUM* EVERTS AND CODLING MOTH, *LASPEYRESIA POMONELLA*(L.). Xing-yue Zhang, Zhi Tang(Plant Quarantine Institute, Ministry of Agriculture, Beijing 100026, China), De-li Fang(Hami Plant Quarantine Station, Xing Jiang 839001, China)

Gamma rays from a Cobalt-60 source were applied to eggs, larvae, pupa and adults of Khapra beetle and larvae of codling moth infesting certain pome fruits to investigate such radation as a quarantine treatment to the pests. A dosage of 42 Kr was heigh enough to kill al stages of Khapra beetle but 100% death of the middle-age larvae delayed up to 53 days after treatment; Dosages over 420 Kr resulted in complete mortality of larvae, pupa and adults immediatly after irradiation, eggs were prevented from hatch at a dose of 3.4 Kr; A dosage as low as 2.6 Kr effectively affected the development of larvae, pupa, and adults.

Radation with a dosage of 244 Kr achieved 100% mortality for mature larvae of codling moth infesting fruits without adverse effects on the quality of treated pears and apples.

RESEARCH ON CONTROL OF POTTED ORNAMENTAL PESTS. Bing-yuan Ye (Institute of Plant Quarantine, Ministry of Agriculture, Beijing 100026, China)

15% Temik granules and 3% Furadan granules were applied experimentally onto potted ornamentals as a means to control the sucking insects on them. It was found that Temik worked better than Furadan. Four kinds of valuable ornamentals were tested. The results are tabulated as follows:

Name of plants	Plant height(cm)	Name of insects	Days for 100% Kill Temik	Furadan
Pittos porum	55-60	Icerya purchas	35	
Kafir-lily	70	Ps.coms-tocki	35	
Chrysan-themum	10-74	Tr.vapo-rariorum	8	15(50% K.)
Chinese hibisus	28-48	Tr.vapo-rariorum	20	20(90% K.)
		Myzusper-sicae	10	

In all cases, the plant species showed no chemical injury.

ASSESSMENT OF SIGNIFICANT QUARANTINE PESTS. Yue Cai, Cong-zhong Zhang (Institute of Plant Quarantine, Ministry of Agriculture, Beijing 100026, China)

To compare the risk degree of insect pests comprehensively, some specific standards have been instituted for assessment.

The risk degree of an insect pest could be determined by the standards based on assessment: 1. Economic importance of the damaged host plant. 2. The seriousness of damage. 3. The possibility and rate of entry(including the way of spreading and activity of the insect pest). 4. Its adaptability in China(including the host range of the insect pest, ecological factors and its fecundity). 5. The domestic distribution and the possibility of transmitting plant diseases. 6. The effect of control and treatment.

After the comprehensive assessment of risk pests based on above standards, relating to the situation of chinese quarantine, the risk pests are classified as follows in accordance with their risk degree: 1. Prohibited quarantine pests. 2. Designated risk pests. 3. Domestic quarantine objects.

ON THE RESEARCH OF SOFT SCIENCE OF PLANT QUARANTINE. Yi-bing Liang(Institute of Plant Quarantine, Agriculture Ministry, Beijing 100026, China)

The science of plant quarantine depends on the developments of many related sciences such as Biology, Ecology, Economics, Law, Sociology and So on. The achievements and results of research work in the above-mentioned fields are applied to the plant quarantine after re-creation made by scientists of plant quarantine.

However, attention should be paid to the fact that the plant quarantine depends not only on science and technology but also on the soft science which is related with some social science and management science. Both hard science and soft science are of great importance to plant quarantine.

This paper has analized the tasks of plant quarantine in soft science which are important and should be done as follows: the research of information appraisal of epidemic for the harmful organisms; the research of Pests Risk Assessment(PRA); the research of tactics and policy decision of quarantine; etc..

A research method of plant quarantine in soft science has been given. The key poit of it is to reresearch on the advanced technology and new results in sciences including social science.

PRELIMINARY STUDIES ON TOXICITY OF MIXTURES OF METHYL BROMIDE AND PHOSPHINE TO LABORATORY STOCK LARVAE OF *TROGODERMA GRANARIUM* EVERTS(COLEOPTERA: DERMESTIDAE) UNDER DIFFERENT TEMPERATURES. Yue-jin Wang, Ke-sen Li(Institute of Plant Quarantine, Ministry of Agriculture, Beijing 100026, China)

When the laboratory stock larvae of *Trogoderma granarium* were fumigated with the mixtures of methyl bromide and phosphine in different proportions at 25°c, the synergism distinctly appeared compared with the fumigants acting independently. The higher proportion of phosphine was more effective. At 5°c, 15°c, 25°c and 35°c the mixtures in proportion of 100:3 also showed synergism, but the synergistic degrees were not same in different temperature ranges. Between 15°c and 25°c, the temperature contributed much more to the synergism. In consideration of the fumigation practice, the best proportion of the mixture may be about 100:3.

#1

LARGE-SCALE FUMIGATION OF SEED-GRAIN WITH A LOW DOSE OF PHOSPHINE.

Zhiwu Zhao (Jilin Grain Oil Food Technical College / China)

In June, 1989, in Jilin Province Longan Seeds Company I used a low dose of Phosphine to conduct large-scale regular fumigation for preventing and killing off insects pests in seed-grain. Before the end of October there were not any insects pests to be found, and the effect of killing off insects pests was 100%. The company stored more than 2000 tons of Surplus crossbred seed-maize (insect pests density 0.02head/kg) in seven old standard barns. There was all the barn capacity 11426m^3 and all the seed-maize heap 3289m^3 there. The average dose of phosphine 0.77g/m^3(the all PH_3 dose 9kg) and 27kg of AEP pills were needed. We determined to conduct the fumigation with 50% of regular dose, the main grounds of which were that in the room test the lowest effective lethal phosphine concentration for insects pests was 0.02-0.04g/m^3 and the influence on the germination percentage of the seed-maize of high moisture content must be prevented. The main experience was as follows: 50% of the dose was saved, the product Ct is used to prolong the closed time for five days, the quality of airtight condition was improved to keep the effective lethal concentration for insect pests, and the early fumigation was carried out to decrease the damage of insect pests. The moisture content of seed-maize was 14.1%, though it was higher, but did not influence on the germination percentage.

#2

"9044" FUMIGANT. Zhi-dan Cao, Jian-guo Tian (Shaanxi Institute of Cereals and Oils, Xian 710082, China)

Carbonyl sulfide (COS) is a colorless, tasteless and odorless liquid. Boiling point is −50.2℃, so that is always gas in normal temperature condition. We first used this fumigant to control stored product pests. Its effect was very good in mortality 99% or 100% for the adults of maize weevils (*Sitophilus zeamais* M.), red flour beetles (*Tribolium castaneum* (H.)), lesser grain borers (*Rhizapertha dominica* Fab.) and the larvae of black carpet beetle (*Attagenus unicolor japonicus* R.). There were not any chemical matter residues in cereals that were fumigated by Carbonyl sulfide. 50g / kg(mouse body weight) fumigated rice fed to each mouse every day. totally fed seven days. All tested mice had no dies and any pathalgical changes in organs.

#3

A STUDY REPORT OF MIXING AIP WITH CH_3BR FOR GRAIN FUMIGATION.

Zhong-xiang Ma (Heilongjiang Province Grain School, Harbin 150080, China)

Fumigation is an important measure for control of store insects at present. For the sake of overcoming grain pollution and preventing the development of insecticide-resistance and improving effect of disinfestation, we have studied fumigating insects with a mixture of AIP and CH_3BR. In 1977, 1979 and 1989, we have fumigated insects in grain store-house with AIP and CH_3Br at Yian, Suihua, Ningan, Heilongjiang province. Through our tests, this method had been used in our province extensively. Volatile speed of CH_3Br is fast, it reaches high concentration after half an hour to an hour, after a few hours, most of insects would be killd, and PH_3 decomposed from AIP reaches high concentration after 44-52 hours. In the same airlight environment the tiem required for reaching high concentration is different, from 0.5-1 hour to 44-52 hours, so that the insects would be poisoned two times in the same environment. It disturbs physiology of insect adaptability to fumigants and improves insecticide effect.

When the two kinds of fumigants are mixed, both of them can act well particularly, and insufficiency of each can be avoided. It solved the problem of development of specific and cross-resistance induced by using single fumingant, and improved insecticide effect. It avoided pollution caused by repeated fumigation and corresponded with the principle of safety, economy and high effect.

#4

CROSS—RESISTANCE OF MALATHION RESISTANT STRAINS TO SOME ORGANOPHOSPHORUS INSECTICIDES IN *SITOPHILUS ZEAMAIS* (L.) AND *TRIBOLIUM CASTANEUM* (HERBST) IN CHINA.

Li Yan—sheng, Li Wen—zhi (Chengdu, Grain Storage Research Institute, Ministry of Commerce; Chengdu, 610031, China)

A susceptible strain of *Sitophilus zeamais* was selected for resistance to malathion. The initial selections during 24 generations of breeding in malathion—impregnated filter papers method were made at 0.25% concentration increading to 2.6%. A resistance level was measured in similar manner and the increase in tolerance was 10—fold when selected progeny was compared with the parent strain. The cross resistance spectrum of strain selected to seven organophosphorus insecticides was measured and cross resistance levels were 9—fold for tetrachlorvinphos, 5—fold for fenitrothion and pirimiphos methyl, 4—fold for bromophos, 3—fold for phoxim and etrimphos, and 2—fold for chlorpyriphos methyl. But triphenyl phosphate was not synergistic with malathion in the strain selected. Cross resistance was also found in a wild malathion resistance strain of *Tribolium castaneum*. The resistance level measured in the strain were lower (<9—fold) to seven organophosphorus but very high to malathion (82—fold). Triphenyl phosphate was strogly synergistic with malathion in the resistant strain.

#5

A STUDY ON THE APPLICATION OF GRAIN PROTECTANTS TO CONTROL STORED GRAIN INSECTS OF PEASANT HOUSEHOLD.

Han-qing Ai (Changde Grain Bureau, Hunan 415000, China)

A series of experiments has been carried out in 27 months, by mixing stored grain with eight dosages (0.1-1ppm) of K-obiol, to eight dosages of Malathion (12-35ppm), or Pepper (300ppm) for storage with 6 kinds 83041 kg of stored grain in 524 small storehouses of peasant household in six counties. The results showed that these grain protectants, such as K-obiol, Malathion and Pepper, is successful in controlling the stored grain insects of peasant household. And the effect of protection of K-obiol is obviously much better than the others. The efficient period is: K-obiol 12-15 months, Malathion 8-12 months, Pepper 9 months. K-obiol and Malathion degraded during its storage period, nearly no thing to be left. The residue of them on the grain is below the standard of the FAO and the standard of the state public health.

#6

A STUDY ON THE TOXICITY OF HUABAO, A PLANT PROTECTANT WITH NO PUBLIC NUISANCE UPON THE COMMON PIERCING-SUCKING MOUTHPARTS PESTS OF GARDENS.

Jing-jiang Lan (Wuhan Institute of Gardens, Wuhan 430062, China)

According to the characteristics of expansion and prevention of garden pests Huabao, a plant protectant with no public nuisance has been prepared and developed. Several different levels of toxicity of Huabao upon more than 20 species of piercing-sucking pests have been tested, such as Coccoidea, Chermoidea, Aleyrodoidea, Aphidoidea, Tingidoidea, Tetranychoidea, Thripoidea, etc.. The results of the tests show that Huabao(HB) has strong effect of killing by contect on many piercing-sucking pests. The regressive relation between HB concentration and the probability of death rate is very significant. The HB solution can easily adhere to insects bodies. Over 95% expected death rate can be obtained if attention is paid to different stages of pests, the solution of HB and the quality of spraying. HB is of special oroma which does not injury plants and on the contrary it conduces to plants growing. Moreover, it is good for health, and does not pollute the environment.

#7

A STUDY OF COMBINED USE OF MALATHION WITH DELTAMETHRIN FOR THE CONTROL OF STORED GRAIN INSECTS. Jiadong Chen (Guangdong Institute of Cereal Science Research, Guangzhou, 510310, China), Rusong Lu and Zhijun Lo (The Cereal bureau of Nanhai County of Guangdong Province),Shicheng Wu, Jie Pan and Taixing Guan (Dali Cereal Station of Nanhai County of Guangdong Province)

Deltamethrin and malathion (high quality) are used as protectants for the control of stored grain insects in China. It was found in field applications that Rhizopertha dominica was the highest tolerant species to organophosphorus insecticide as malathion among common beetles, while deltamethrin was highly effective to this species. Owing to the cost for application, the independent use of deltamethrin was hard to be popularized on the level of individual producers. For the sake of reducing the cost of application and to delay the development of resistance, a series study of malathion combined with deltamethrin were conducted in nine proportions at Nanhai County, Guangdong Province. The treated paddy were sampled at intervals for bioassay. The results showed that the combined use gave good protections of common beetles including R. dominica. The practical proportions of malathion and deltamethrin were 25+0.3, 25+0.5, 30+0.1, 30+0.3, and 30+0.5ppm. The most practicable proportion was 30+0.1ppm.

#8

INTRA- AND INTERPOPULATION RESPONSE TO TRICALCIUM PHOSPHATE IN TRIBOLIUM STRAINS. Prus, Mirosława /Institute of Ecology, Polish Academy of Sciences, 05-092 Łomianki, Poland/

The experiments were carried out on two species of Tribolium: Tribolium castaneum cI /Hbst./ and T. confusum bIV Duval. Within these two species two groups of 6- and 7-instar group were discerned. The animals were exposed to various concentration: 0.5, 1.0 and 1.5% of tricalcium phosphate /TCP/ and their developmental time, survival, fecundity of eggs and hatchability were investigated.

The developmental time and survival of T. confusum population is depressed stronger than those of T. castaneum. There are not differences between 6- and 7-instar groups in response to various concentration of TCP. The results obtained for fecundity showed that this trait is more restricted in T. castaneum than in T. confusum. Hatchability in all experiments was the same.

#9

COPULATION RELEASE PHEROMONE FROM THE COWPEA WEEVIL Callosobruchus maculatus. Kanju Ohsawa, Hiroshi Honda and Izuru Yamamoto(Faculty of Agriculture, Tokyo University of Agriculture, Japan)

A copulation release pheromone of the cowpea weevil which induces the male to extrude its genital organ and to attempt copulation, was found to consist of two synergistically acting fractions, each having low activity. One fraction was a mixture of some hydrocarbones:11-methyl -nonacosane, 13-methylnonacosane, 3-methylnonacosane and 11,15-dimethyl-nonacosane. The other fraction consisted of the following dicarboxylic acids: 3-mthylheptanedioic acid, octanedioic acid, 4-methyloctanedioic acid, 2,6-dimethyloctanedioic acid and nonandioic acid. The substance responsible for copulation release activity was 2,6-dimethyloctanedioic acid. A sex attractant was also released from the female weevil and identification work is still being pursued.

#10

ADULTICIDAL ACTIVITY OF BACILLUS THURINGIENSIS FORMULATIONS AGAINST THREE SPECIES OF COLEOPTERA INFESTING STORED PRODUCTS. Tian-rong Qian (Shanghai Animal & Plant Quarantine Service, Shanghai 200032, China), Whitney S. Cranshaw(Department of Entomology,Colorado State University, Fort Collins,Colorado,80523,U.S.A.)

Two Bacillus thuringiensis strains (var. tenebrionis and var. san diego) were tested for their activity against adults of 3 coleopteran pests of stored grains. ABG 6263 (var. tenebrionis) was effective for the lesser grain borer, Rhyzopertha dominica (F.). Its efficacy was more than 60% at the lower concentration tested (400 ppm of formulation) in 2 weeks of treatments, and was 100% at the high concentrations tested (10,000 and 2,000 ppm). On the contrary, the confused flour beetle, Tribolium confusum Jacquelin du Val, was not effctive to ABG 6263-amended wheat flour at any of the tested concentrations(80 to 10,000 ppm formulation). The sawtoothed grain beetle, Oryzaephilus surinamensis(L.),showed an intermediate response to var. tenebrionis applied to oatmeal. Limited testing of var. san diego(M-One) indicated its low efficacy against lesser grain borer at the highest concentrations tested (940, 455/Colorado potato beetle unites/gr) but did not give significant control of the sawtoothed grain beetle. In addition some significant insecticidal activity was also associated with the diluent carrier of the ABG 6263 formulation. These results suggest that the Bacillus thuringiensis var.tenebrionis could be potential biological control agents for certain stored products beetles

#11

INERT GASES TO CONTROL THE EGGS OF STORED GRAIN AND GRAIN PRODUCTS INSECTS. M. Y. Hashem (Econ. Ent. & Pesticides, Fac. of Agric., Cairo Univ., Egypt), Ch. Reichmuth (Biologische Bundesanstalt Berlin, Inst. Fur Vorratsschutz, Germany).

The treatment with inert gases (CO_2 and O_2)are being developed more and more as a substitute for the use of chemical insecticides of stored product insect control. At high temperatures, they have a rapid effect than at low temperatures. In this study, different gas mixtures from O_2, CO_2 and N_2 were prepared to controlling the eggs of *Ephestia elutella*, *Corcyra cephalonica* and *Sitotroga cerealella* at 15°C and 25°C for different exposure periods. A method of preparing the different gas mixtures of the pure components was developed by using very accurate manometers. 20% and 40% CO_2 for 7 days were sufficient to control all insect eggs at 15°C and 5 days at 25°C. The eggs of *E. elutella* at all CO_2 concentrations showed the most pronounced tolerance at both temperatures. A period of 7 days was necessary at both temperatures tested using 96% N_2 and 4% O_2.

#12

MEASURING THE BIOTYPES OF Callosobruchus maculatus. R. Mitchell (Dept. of Zoology, Ohio State University, Columbus, OH 43210), P. F. Credland (Dept of Biology, Royal Holloway & New Bedford College, Egham, Surrey TW20 0EX, England), and K. Fujii (Inst. Biological Sciences, University of Tsukuba, Tsukuba, Ibaraki, 305, Japan).

Comparisons of the biotypes of the insect require a standard methodology that eliminates the variables known to produce secondary responses by the beetles. A protocol was developed to eliminate the effect of larval competition, provide a surplus of oviposition sites, and standardize host qualities in a constant environment. The results validate the protocol as a standard way to measure the key traits that vary from biotype to biotype. Laboratory strains may respond to culture regimens by increasing fecundities to almost 120. As a rule fecundities are stable around 70-80 eggs. Dispersion of eggs is fairly constant within a biotypes but differs widely among biotypes. Similarly larval patterns of larval competition differ among biotypes.

#13

STUDIES ON BIONOMICS AND POPULATION DYNAMICS SIMULATION OF *RHIZOPERTHA DOMINICA* FABRICIUS. Zong-lin Qin, Guang-can Li, Long-shu Li, (Chengdu Grain Storage Research Institute, Ministry of Commerce, Chengdu, 610031, China)

In this study, the biological habits and ecologics of *R. dominica* was surveyed under different temperature and relative humidity with whole wheat flour. Results showed that: The temperature range of *R. dominica* development is between 16.6—38℃ and the most suitable range is between 32—36℃. Development threshold temperature and available accumulated temperature are different with the change of RH, at 55%, 65%, 75% and 85%, the threshold temperature are 18.2±1.5℃, 16.7±0.8℃, 16.6±0.3℃, 16.6±0.4℃ respectivly, the average available accumulated temperature of a generation are 731±89, 768±47, 682±15, 669±20 day degree respectivly. Every stage development duration, survival rate, adult's fecundity and longevity of *R. dominica* are different with the change of the temperature and RH. *R. dominica* can not reproduce below 20℃. The innate increase capacity(r_m) increases with the increasing of temperature and RH, at 24℃, RH 55%: r_m=0.0121, at 36℃, RH 85%: r_m=0.0828. The population dynamics dimension—changeable matrix computer model dependent on the change of temperature and RH was established. The model can better simulate the population dynamics of *R. dominica*.

#14

POPULATION REGULATION MECHANISMS IN TRIBOLIUM FREEMANI HINTON (COLEOPTERA: TENEBRIONIDAE)

Osamu Imura (National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki 305, Japan)

Tribolium freemani Hinton was discovered in imported grain in Japan and found to be a potential pest of stored products. According to a Chinese entomologist, this beetle is widely distributed in Sinkiang, China. Laboratory populations of T. freemani maintained a fairly low and stable equilibrium population. The beetle had several traits which reduced their development and population growth: pupation was markedly retarded under crowded conditions; egg production was significantly reduced in even a slightly conditioned medium; and larvae and adults voraciously predated eggs, pupae and callow adults. Although T. castaneum and T. confusum, serious pests of stored products, have similar traits, a combination of these traits which were more intensified in T. freemani than in T. castaneum and T. confusum made the population dynamics of the former species very different from those of the latter two.

#15

A STUDY OF BIOLOGY AND CONTROL MEAESURES OF THE LESSER GRAIN BORERS (Rhizopertha dominica F.)

Ji-wu Zhan (The Hunan Grain Academy, Changsha 410002, China)

Through the raising experimentation and full barn observation, the various biological characteristics of the lesser grain borer (Rhizopertha dominica F.)in area of the middle part of Hunan province in China have been identified. On account of the fact that the starting temperature of the development of the lesser grain borer is 16.50℃. Therefore, the key link in the control of the growth and the development of the lesser grain borer relies on low temperature. Consequently, in the mountainous area where natural low temperature can be utilised to induce a progressive death to the lesser grain borer, while in areas lacking a natural low temperature, such a purpose can be fulfilled by reducing the temperature through mechanical way. As for in those areas where the method of low temperature control can not be applied, then the preventive and treatment measures can be carried out by making use of ALP fumigation as well as such protecting agents as K-obiol, Melathion and α-pinene, with the proper use of such chemical preventive and treatment measures, satisfactory results can be obtained.

#16

PREMATING AND POSTMATING ISOLATION BETWEEN Tribolium freemani HINTON (Coleoptera:Tenebrionidea) AND Tribolium castaneum (HERBST).

Fujii, H., H. Ikenaga and Nakakita H. (Stored Product Entomology Labo., National Food Research Inst., M.A.F.F., Kannondai, Tsukuba, Ibaraki 305 Japan)

T. freemani is a sibling species of T. castaneum which can easily produce sterile hybrids. Although we have some biological data about T. freemani, obtained from a strain rediscovered population in Yokohama, we did not know the exact behavior of the species under field conditions. To speculate field conditions of T. freemani, it is important to evaluate the possibility of sympatric existence of both T. freemani and T. castaneum, dominant species in the field. Using a Yokohama strain of T. freemani, we studied premating isolation by multiple choice method and postmating isolation by rate of sterilization of eggs produced by interspecific crossing under laboratory conditions. Our results showed some aspects of mating behavior, in paticular indicated a difference of mating frequencies, between both species under competitive conditions.

#17

EVALUATION OF RICE, AND BREEDING FOR RESISTANCE TO SITOTROGA CEREALELLA IN STORED GRAIN. Liang-you Zhang, Jung-tsung Wu, Zhung-wen Lu (South China Agricultural University, Guangzhou, 510642, China)

Among 109 rice varieties screened, 48 exhibited resistance and 34 moderate resistance to Sitotroga cereallella (AGM). Seventy AGM-resistance and moderate resistant varieties were tested for resistance to Nilaparvata lugens. 24 were resistant, and 3 moderately resistant. When the AGM-resistant rice soures were used as donor parents, the resistance was highly heritable and easily recombined with other agronomic traits. Consequently, breeding lines with resistance were available. A released variety "Honyangai", which had high resistance both to AGM and rice blast, has been planted on 60000 ha in Guangdong province, and its yield averaged 6-6.8t/ha.

#18

DIVERSITY OF TRIBOLIUM POPULATIONS. Prus, Tadeusz /Institute of Ecology, Polish Academy of Sciences, 05-092 Łomianki, Poland/

Investigations were made of duration of subsequent instars and of total development in discerned phenotypic groups in Tribolium populations; of maximum weight during development and of fecundity and hatchability in different strains of Tribolium.

T. castaneum reveals higher tendency of phenotypic diversity within a group of four strains than does T. confusum. Both investigated strains consist of 6- and 7-instar group, however their incidences differ. In cI this proportion seems to be 1:1 and in cIV 7-instar group is clearly prepondering over the 6-instar group.

In T. confusum such diversity was also observed but only in bIV strain whereas bI strain is homogenous in this respect. Similar trends were observed in black mutants of these species, semidominant "sooty" strain of T. castaneum was much more differentiated than "ebony-2" of T. confusum which was almost homogenous.

#19

THE NATURAL ENEMIES OF THE AMERICAN COCKROACH PERIPLANETA AMERICANA LINNAEUS. Guangqiu Yang, Chaosheng Wei (Reasearch Institute of Microbiology, Guangzhou 510250)

The resusts of the studies on the parasitoids Tetrastichus sp. and Evania sp in the three different stages of the eggs of P. americana from 1983 to 1985 were reported in this paper.

The parasitiation of Tetrastichus sp. was 82.59%, and of Evania sp. 17.41%.

99.9% of American cockroach egg cases was parasitized.

The rate of emergence of Tetrastichus sp. was about 87.95%, and of Evania sp. about 95.38%.

#20

#21

REPORT ON THE INTEGRATED CONTROL OF STORED PRODUCT MITES. Dao-long Xu, Li-bo Huang, Ying He, Xiao-bing Cheng and Zhen-hui He (The Grain School of Yunnan Province)

Most of the stored product mites belongs to the family Tyroglyphidae, Suborder Acaridida, with no stigmata, the respiration must be carried on through the thin and soft integument, they are very sensitive to the dry environment. Since the population densities of mites are influenced by the physical factors of the storehouse. Then the mites control may be doing with some effective and basic procedures to attain the aim of prevention, such as keep as far as possible the sanitation of warehouse, the good quality of the stored product and by use of air-blowers keep the water concentration of grain below 12%.

The experiments on rational application of insecticides in large scales have accumulate a lot of effective experiences for elimination of mites in warehouse, which mainly by using of lower dose of ALP and DDVP for fumigation, and to combine with some surface protective treatments by using of malathion or pyrethroid (Decis).

#22

MITE PROBLEMS IN STORAGE AND CONTROL TECHNIQUES UNDER IRANIAN CONDITIONS. N. Shayesteh & A. A. Pourmirza (Dept. of Entomology, University of Urmia, P.O. Box 165, Urmia 57135, Iran).

More than five hundred species of mites have been collected from various parts of Iran. The distribution and habitat have been recorded for all species. Under Iranian conditions the most important and destructive mites belongs to Tetranychidae, Eruphidae, Phytoseidae, Rhizoglyphidae, Lardoglyphidae, Glycyphagidae, Chortoglyphidae and Carpoglyphidae. Out of more than five hundred species of mites, ten of them are mainly involved in damaging stored products and man sanitation problems. Under Iranian conditions some mites control techniques, viz. inert dust application, heat treatment, cold treatment, using of atomic energy, fumigatien and surface treatment have been employed to control their activities. On the whole, damages by mites is significant and in any rural area due to insufficient practices of preservation of stored products and over looked their activities losses are noticeable.

#23

A NOVEL α-AMYLASE INHIBITOR FOUND IN THE WILD COMMON BEAN RESISTANT TO THE MEXICAN BEAN WEEVIL (ZABROTES SUBFASCIATUS). Kazunori Suzuki (Univ.Tsukuba, Tennoudai 1-1-1, Tsukuba, Ibaraki, Japan), M. Ishimoto (Natl.Agr.Res.Center, Kannondai 3-1-1, Tsukuba, Ibaraki, Japan), F. Kikuchi (Univ.Tsukuba), K. Kitamura (Natl.Agr.Res.Center)

The Mexican bean weevil (Zabrotes subfasciatus) is one of the most important pests of common bean (Phaseolus vulgaris) during storage. The common bean contains an α-amylase inhibitor which inhibits larval amylase activity of Callosobruchus chinensis, but hardly inhibit the activity of Z. subfasciatus. Recently, some accessions of the wild common bean have been found to possess high levels of resistance against Z. subfasciatus. A novel α-amylase inhibitor which isolated from one of the accessions, strongly inhibited the amylase activity of Z. subfasciatus. Feeding tests demonstrated that the larval growth of Z. subfasciatus was retarded in artificial beans containing the purified α-amylase inhibitor at a concentration of 0.3%. On the other hand, though the inhibitor does not suppress the amylase activity of C. chinensis, the larvae could not develop well on the artificial beans containing the inhibitor at 0.3% and completely died at more than 1%.

#24

THE INFLUENCE OF TEMPERATURES AND RELATIVE HUMIDITIES ON THE GROWTH AND DEVELOPMENT OF ZABROTES SUBFASCIATUS (BOHEMAN). Yongxue Deng, Wenbin Zhu (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

A study of Zabrotes subfasciatus was made under five temperatures (20℃、24℃、28℃、32℃、36℃) and relative humidity 90% on Vigna unguiculate. The results showed that the biological zero of immature stage was 15℃, and the zone of favorable temperature ranged 28℃-32℃. The influence of the relative humidities on growth and development was also observed.

#25

STUDIES ON THE GEOGRAPHICAL POPULATION OF CHINEASE COWPEA WEEVIL CALLOSOBRUCHUS CHINENSIS L.- COMPARISION OF THE BIONOMICS AND ECOLOGICS OF THE ADULT INSECTS. Yongxue Deng, Lungshu Li, Wenbin Zhu (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

This paper deals with comparative studies on the bionomics and ecologics on Chinese cowpea weevil adults collected from Chongqing and Xicang area, Shichuan Province. The results showed the differences of bionomical and ecological characters between the two populations. The causes of differences are analysed and discussed. It is considered that they are two different geographical populations.

#26

TROPICAL CROP PESTS IMPORTANT AND NOT KNOWN TO OCCUR IN CHINA. Zhong-mei Chen (The Headquarters of Animal and Plant Quarantine Service, Beijing 100026, China), Jun Zhang (Hangzhou Animal and Plant Quarantine Service, Hangzhou 310021, China) , Ji-yong Li (Haikou Animal and Plant Quarantine Service, Haikou 570011, China)

The Tropical Crops including Rubber, Coffee, Cacao, Pepper, Coconut, Oilpalm, Agava, Cashew etc. are planted in Tropical and South sub-tropical regions of China. Most of them are foreign origin and it seems possible and easy for pest species to be introduced with the crops and established in new areas. Extensive investgation were done during 1960-1986 on the tropical regions. About 39 species (belonging to 17 families) Major Tropical Crop Pests in China (MTCPC) are recorded. In recently years many serious tropical crop pests which are not known to occur in CHINA (e.g. Mango seed weevils, Fruitflies, Coffee berry borer, Scale insectes etc.) and introduced with the plant genetic resources was found upon quarantine inspection at some ports of Animal and Plant Quarantine Service. Prevention of permanent establishment of immigrant pests begins with survey and detection. Prompt and accurate identification is the key job. China Animal and Plant Quarantine Service (CAPQS) distributes reference collections of 44 species Major Tropical Crops Pests Not Known to Occur (MTCPNKO) in China (belonging to 15 families) in order to promote exchange of quarantine information and specimens. We would appreciate cooporation with our counter-parts throughout the world.

#27

IDENTIFICATION OF FOUR SPECIES OF THE CASTANEUM SPECIES-GROUP OF TRIBOLIUM (COLEOPTERA: TENEBRIONIDAE). Shengfang Zhang, Yongping Liu (Plant Quarantine Institute, Ministry of Agriculture, Beijing 100026, China)

The Tribolium species of plant quarantine and economic importance are reviewed. A species of the genus from Northwest China previously identified as T. madens is actually T. freemani and as such, it formed a new record of this storage pest in China. The characters for distinguishing T. freemani, T. castaneum, T. audax and T. madens are given. The comparation of male genitalia of the species reveals that T. freemani is very likely a closer species of T. castaneum than either of T. madens or T. audax.

#28

THE PLANT QUARANTINE MANAGEMENT OF THE TETRADACUS CITRI CHEN IN CHINA.

Wang Chen-lin,(General Station of Plant Protection, Ministry of Agriculture Beijing 100026, China)

This paper brifely introduce the plant quarantine management against Tetradacus Citri Chen which is one of important plant quarantine pests in china. Owing to neglect the plant quarantine measures, The occurance of this pest is more popular in Sichuan, Hunan, Hubei, Guizhou, Shaanxi, Guanxi, Yunnan provinces from 1960 to 1979. Since 1980, the plant quarantine measures are carried out as following:1) Establishment of plant quarantine system, 2) Establishment of proper plant quarantine principles,3) Training and investigation is carried out by the plant quarantine staff every year, 4) integrate pest management combined the artificial measure and agricultural control, 5) Unite control and cooperation. Because we strengthen the plant quarantine measures and management of this pest, this pest spread it is very seccessful to stop and manage in china.

#29

QUARANTINE AND CONTROL OUTBREAK OF FALL WEBWORM (HYPHANTRIA CUNEA) IN SHAANXI PROVINCE. Xing Liu, Gaohua Li, Youxin Ma (Xi'an Animal and Plant Quarantine Service, Xi'an, Shaanxi 710068, China)

This article is to present the destructiveness and the steps taken in the control of the Fall webworm (H. cunea) breaking out in some areas in Shaanxi Province from 1984 to 1990. The economical benefit and the main experience from the control of the pest are described. The results of the survey revealed that the pest was carried into Shaanxi Province by air through industral packages from the foriegn epidemic-area. This is a direct incidence of long distance spreading of fall webworm exempted from the plant quarantine authorities. It provides a scientipic basis for quaratine legislation in China

#30

THE LIST AND KEY OF STORAGE PESTS WHICH HAVE BEEN FOUND IN EXPORT SOYBEAN AND CORN IN HEILONGJIANG PROVINCE. Shufan Duan (Harbin Animal and Plant Quarantine Service, Harbin 150040, China)

Heilongjiang province is one of the important base for export cereals in China. While the reform and open policy has been crarried out, the export amount of soybean and corn is about 1,500,000 tons in the province a year. The storage pests are limited so strictly in some trading contracts that some countries and areas prohibit the entrance of any storage pests. It is very difficult to implement the contract terms. Investigation on the species of storage pests living in the export soybean and corn in the Province has been carried out for three years since 1986. We have found 2 orders, 18 families, 31 species through our quarantine work and the survey. A key to the adult was complied in order that the owner of the cargo may prepare his goods for inspect and the quarantine officer have the reliable information to inspect in the scene.

It was found to be valuable by the related departments through practice to use and increase the rate of finding out the storage pests. The related department also thought that it increase the economic benifit to the export of cereals. It will be used for singing a trading contract as well as to claim for indemnity from the export counterpart. It will be of certain value to teaching in school and scientific research.

#31

THE EXPORT QUARANTINE OF AGRICULTURE PRODUCTS IN SICHUAN. Xue-qian Zhao, Cheng-lun Xie, Jing-an Fan (Chengdu Plant Quarantine Service, Chengdu 610041, China)

There are 188 species of the export agriculture products in Sichuan. The 55 pests, which belong to 27 families, 8 orders, were discovered and identified through quarantine inspection. Among them, two species are the quarantine objects, one species is the designated pest. The 19 species are usually discovered. On the quarantine inspection of export agriculture products in Sichuan, we take strictly the integrated measures of management of the quarantine laws and regulation, investigation of the pest situation, prevention and kill in the place of production and inspection of delivery goods. Before delivery goods, the pests carried on the export agriculture products will be prevented and killed. It can ensure that export agriculture products are health and unharmful, be advantageous to safety delivery and successful export.

#32

EVALUATION OF A ENTOMOGENOUS NEMATODE FOR CONTROL OF GERMAN COCKROACHES. Appel, A.G. and E.P. Benson (Department of Entomology, Auburn University, Auburn, Alabama 36849-5413 USA).

The entomogenous nematode, Steinernema carpocapsae (Weiser), was evaluated in laboratory and field experiments against the German cockroach Blattella germanica (L.). Nematodes were confined in proprietary moisture retaining plastic stations that could be readily entered by cockroaches. Stations containing 0.5, 1, 2 or 5 million nematodes were evaluated in continuous exposure tests and in Ebeling choice boxes. Mean LT_{50}'s ranged from 2.1 days for 0.5 million nematodes in the continuous exposure test to 45.8 days for 5 million nematodes in the choice box test. Repellency of the stations increased with increasing numbers of nematodes. Twelve stations each containing 2 million nematodes were placed in cockroach infested apartments. Stations were replaced monthly to insure nemtode viability. Trap catch declined over time indicating a reduction in the cockroach population. Trap catch declined less than 67% by week 8 after treatment. Nematode stations provided significant control of German cockroaches in apartments.

#33

S-41311 AS THE PROMISING COCKROACH CONTROL AGENT WITH HIGH KNOCKDOWN ACTIVITY AND THE NEW METHOD FOR EVALUATION OF KNOCKDOWN EFFICACY. Senbo, S.; Makita, M.; Kawada, H.; Hirano, M.; Abe, Y. (Agricultural Science Research Laboratory, Takarazuka Research Center, Sumitomo Chemical Co., Ltd., Takarazuka, Hyogo *665*, Japan)

Knockdown effect is one of the important property of cockroach control agent. Knockdown time (ex. KT_{50}) has been generally used to evaluate the knockdown effect. However, the linear correlation between the knockdown time and the amount of insecticides becomes undistinguishable when KT_{50} value becomes smaller, because of increasing error in observation. For this reason, the new evaluation method was attempted to measure the distances between spray point and the sites where cockroaches knocked down.

We could get good correlation among the moving distance of cockroach and the amount of insecticides examined in our study. S-41311, the new synthetic pyrethroid, showed the highest effect among the insecticides examined. The moving distance (MD_{50}) of 1.0% S-41311 was less than 10 cm against German cockroaches.

#34

TERMITES: ROLE OF SYMBIONTS IN CARBOHYDRATE METABOLISM. P.C. Veivers and M. Slaytor (Department of Biochemistry, The University of Sydney, Sydney, N.S.W. 2006, Australia)

Higher and lower termites secrete their own cellulases in sufficient quantity to provide glucose for their metabolic needs, as determined by oxygen consumption rates and cellulase activity as measured against Sigmacell 20. However, lower termites also have cellulolytic protozoa in their hindgut which can degrade cellulose to acetate, H_2 and CO_2; these protozoa clearly do not digest cellulose for the termite, the view commonly held by biologists. All termites have complex mixtures of bacteria which include both facultative and strict anaerobic bacteria. but only a small number of facultative bacteria have been cultured. No cellulolytic bacteria have been isolated from termites and glucose is not found in the hindgut. This suggests that the bacteria do not use cellulose or glucose though other polysaccharides such as hemicelluloses can be metabolised. The higher termite *Nasutitermes walkeri* has negligible cellulase activity (<1% of the total) in the hindgut but significant hemicellulase activity against xylan and arabinogalactan (50 and 70% of the total activity respectively). Termites do not possess pyruvate dehydrogenase and hence cannot use pyruvate. We believe that pyruvate is an important carbon source for the bacteria in the hindgut where it is converted into acetate. Acetate can be detected in the haemolymph of termites and the active uptake of acetate from the hindgut has been demonstrated in the termite *Mastotermes darwiniensis* and the wood roach *Panesthia cribrata*. Acetate can be used by the termite as termites possess an efficient acetyl CoA synthetase.

#35

THE ACTION OF LIGHT ON THE EXISTENCE AND ACTIVITES OF COPTOTERMES FORMOSANUS SHIRAKI. Fu Bing (Nachang Termite Prevention and Control Research Institute, Jiangxi, China)

Light, as an ecological factor, is a complex environmental factor and has been directly playing an important role in the field of entomology. As every entomologist knows, Coptotermes formosanus Shiraki, a kind of insect, leads a hidden life and likes the environment that provides warmth and moisture for it to survive. As to light, the author has made a study of its action on the life and activities of Coptotermes formosanus Shiraki. And, according to different intensity of light, he has carried out purposeful experiments in regard to the crawling speed, appetite and mortality of this insect. Judging from the results of the repeated experiments, light can be divided into three spheres so far as its luminosity is concerned. 1. Light sphere for normal life: When the luminosity value ranges from 0 to 50 (candlepower/m²), the Coptotermes formosanus Shiraki is less sensitive to light and can live and crawl as usual. 2. Light sphere possible for existence: When the luminosity value ranges from 50 to 100 (candlepower/m²), the above-mentioned insect reacts to light to a centain degree, but it is still able to adapt itself to this intensity of light and, ronghly speaking, it can live and move in a normal state. However, mortality is getting a little higher. 3. Light sphere impossible for existence: When the luminosity value exceeds 100 (candlepower/m²), the insect can hardly adapt itself to this intensity of light, feeling unwell when crawling, having poor appetite or even refusing to eating anying. On this condition, mortality is visibly on the increase.

#36

THE PRELIMINARY PHARMACOLOGICAL STUDIES ON THE CHEMICAL COMPOSITION OF COPTOTERMES FORMOSANUS AND ON THE EXTRACTS FROM COPTOTERMES FORMOSANUS. Lei Er Chang (Nanchang Termite Prevention and Control Research Institute), Chen Peng Xing (Nanchang Real Estate Vocational Education Center)

In order to find out the edible value and medicinal effect of termites, We have carried out successive tests by using Coptotermes formosanus as testing materials. The results are as follows: 1. The chemical composition of Coptotermes formosanus: moisture content: 70%; protoin: 10.8%; fat: 11.2%. The termite protein is composed of 18 kinds of amino acids. It is a kind of whole protein. 2. The results from drastic toxicity test have proved that the extracts from Coptoterms formosanus are not poisonous to the tested small white mouse after pouring the extracts into its stomach. 3. The preliminary pharmacological test also shows that pouring alchohol-soaked Coptotermes formosanus extracts into the above-mentioned mouse's stomach has evidently strengthened its antihypoxemic and antifreezing ability. The test also shows that using decocted soup of Coptotermes formosanus to pour into the stomach of the said mouse can visibly heighter its antifatigue ability. The above-mentioned effectiveness of the extracts from Coptotermes formosanus has opened up before us promising prospects. The extracts from Coptotermes formosanus not only have certain good curative effect for some diseases caused by anoxia but also provide hopeful medicinal resources for the development of senile health protection, high altitude exercise and astronavigation.

#37

THE ACTION OF TEMPERATURE ON THE EXISTENCE AND ACTIVITIES OF RETICULITERMES SPERATUS KOLBE. Xunhong Cai (Nanchang Termite Prevention and Control Research Institute, Jingxi 330008, China)

This article has reported that temperature had significant influence on the existence, appetite, behaviour and other activities of Reticulitermes speratus, 1. The crawling speed of R. speratus has close relations to temperature. The R. speratus moves at a normal speed at the temperature between 16℃ and 26℃. 2. Temperature affects the existence of R. speratus. It is not suitable for the Reticulitermes speratus to survive both at the temperature below 9℃ and at the temperature over 34℃. The suitable temperature for the R. speratus to exist ranges from 16℃ to 28 ℃. But when the temperature gets higher than 20℃ and continues to go up, a gradually higher mortality is most likely to occur. 3. Temperature has much to do with the appetite of Reticulitermes (1) At the temperature below 9℃ or over 36℃ the R. speratus refuses to eat anything. (2) When the temperature ranges from 9℃ to 16℃ or from 30℃ to 36℃ it eats very little. (3) At the temperature between 16℃ and 30℃ it has normal appetite. (4) In the course of normal appetite, R. speratus is found to have a visibly most greedy appetitive behaviour when the temperature ranges from 18℃ to 24℃. Finally, it has proved by the experiment that the temperature ranging from 18℃ to 22℃ is the most suitable for R. speratus to survive.

#38

CONTROL OF TERMITES DAMAGES OF THE UNDERGROUND PLASTIC CABLES IN KUANGZHOU, CHINA. Shan-xiang Lin (Kuangdong Entomological Institute, 105 Xingang Road, Guangzhou 510260, China)

From March 1989 to 1991, a series of experiments were conducted in Guangzhou to control termites which damaged plastic cables in undergroud. The species of termites and their distributions were investigated also. Three species: Coptotermes formosanus, Odontotermes formosanus, and Macrotermes barnyi are dominant species according to their damages extent. Sampled 556 wells of cable and 1930 trees besides of road, the damaged rate by termites was 39.6% and 27% respectively. Attractant bait and poisoning soil methods were used to control termites, through the practice of two years, these two methods can get successful results.

#39

BIOLOGY OF HESPEROPHANES CAMPESTRIS (FALDERMANN) (COLEOPTERA, CERAMBYCIDAE), A DRYWOOD BORER IN JAPAN.

R. Iwata & F. Yamada (Dept. of Forestry, Coll. of Agr. & Vet. Med., Nihon University, Tokyo 154, Japan)

A cerambycid, Hesperophanes campestris (Faldermann), is distributed in Japan Mainland (Tôhoku; Kantô; Chûbu; Kinki; Shikoku; Kyûshû), as well as in North Korea, China Mainland (Northeast; North through Qīnghǎi Prov.; Middle through Sìchuān Prov.; North Xīnjiāng), North Mongolia, Russia (Ussurii-Primorskii Region), South Kazakhstan, Uzbekistan, and Tadzhikistan. It, together with its European substitute, H. cinereus (Villers) is known as an important drywood-boring species occurring indoors. An investigation was made on the biology of H. campestris by observing its heavy infestation on preserved logs in Kyoto Pref., Japan to give the following results:

Bark surrounding the xylem is essential for the larval development. The larvae have a high resistance against dryness of the logs into which they bore. Although almost all wood species are possibly attacked, statistically significant differences of the adult body lengths, as well as the variation of adult emergence date, were observed among different host wood species. Of all the xylem portions, only the wood near the cambium was preferred by the growing larvae, suggesting that this species preferably utilizes, apart from wood holocellulose, minor nutrients, such as starch.

#40

COMPARATIVE TOXICITY OF FIVE PYRETHROID INSECTICIDES TO SEVERAL STORED PESTS. **B.C. Schiffers** (Unite de Chimie Analytique & Phytopharmacie, Faculte des Sciences Agronomiques de Gembloux, B-5030- Gembloux, Belgium)

Compared to other insecticides, pyrethroids offer distinct advantages such as greater stability on stored grain, far more persistence than natural pyrethrins, and less toxicity for man and warm blooded animals for amounts applied, and should be considered as an attractive alternative for the control of pests resistant to organophosphorous compounds. The efficacy of deltamethrin (considered as the standard), bifenthrin, lambda-cyhalothrin, cyflurhin and permethrin has been compared under standardized conditions (reared out at 27° C and 70% r.h.). For each active ingredient and for six insects (*Sitophilus granarius, S. oryzae, S. zeamais, Tribolium cataneum, Rhizopertha dominica* and *Prostephanus truncatus*) the reagression line of insect mortalities have been established according to increased doses of insecticide applications to wheat grains. The a.i. can be arranged in decreasing order of efficiency: delatamethrin, cyflutrhin, bifenthrin and lambdacyhalothrin. Permethrin is not suitable for this kind of application. The most susceptible insects to pyrethroids are *R. dominica, S. oryzae* and *S. granarius*. . L-Cyhalohrin and deltamethrin are very efficient for the control of *T. castaneum*. These results emphasize the advantages of grain protectant combinations for wheat using the best organophosphorous compounds (pirimiphos-methyl, chlorpyriphos, fenitrothion or malathion).

#41

THE RESISTANCE OF RICE VARIETIES TO THE MAIZE WEEVIL (SITOPHILUS ZEAMAIS MOTSCHUSKY) DURING STORAGE. Wan-shie Dung, Hong-yu Zhang (Department of Plant Protection, HuaZhong Agricultural University, Wuhan 430070, China)

Chose 22 rice varieties on the basis of screening rice varieties. Considered influence upon each other of 13 physicochemical properties of rice varieties. Author used stepwise regression analysis for studing the machanisms of resistance to maize weevil. The result showed: 7 of these physicochemical properties affected significantly rice resistance to maize weevil. Percentage of gaping husks, weight of 1000 grains, grain width, amylose content(%) were correlated negatively with resistance of rice varieties; Hairs on husks, protein content(%), fat content(%) were correlated positively with resistance of rice varieties. Also, percentage of gaping husks affected antixenosis for feeding, oviposition and antibiosis. Weight of 1000 grains affected antixenosis for feeding. Grain width and hairs on husks affected antixenosis for oviposition. Amylose content(%), protein content(%) and fat content(%) affected antibiosis. The influence of percentage of gaping husks was the most marked among 7 physicochemical properties. It reflected the most resistant tendencies. The other 6 physicochemical properties analyzed: grain length, grain length-width ratio, husk raised, grain husk thickness, sugar content(%) did not affect significantly rice resistance to maize weevil.

#42

EFFECTIVE CONTROL OF SOME PLANT OILS ON COWPEA WEEVIL (CALLOSOBRUCHUS MACULATUS FABRICIUS). Wanxie Dung, Honyu Zhang, Youbo Guo (Department of Plant Protection, Huazhong Agricultural University, Wuhan 430070, China)

In labarotory, mixing 400g mung bean with 0.4ml, 2ml, 3.2ml oils of cole-seed, prickly ash seed, sesame, cotton-seed and pheasant pepper seed. Then, the treated mung beans were infested with 10 pair cowpea weevil adults, all of which were 1 day old, at 28±3℃ and 75±5%RH. The results revealed: at a dose of 1ml/kg, effective control of pheasant pepper seed oil was the most marked among 5 oils after 2 months of treatment, percentage of gram weight loss was 1.25% while untreatment sample was 43.25%; secord was prickly ash essd oil; third was cole-seed oil; cotton-seed and sesame oils were less effective. At a dose of 5mg1/kg, all of oils were effective, percentage of mung bean weight loss was 0 after 8 months of treatment; The study informed that oils of these plant seeds influenced embryonic development of cowpea weevil, the treatment eggs period was prolonged, embryonic development was abnormal. Oils of plant seeds were the low costs, local availability, safty to the environment. There is no notorious residual problem. So we recommend it to be used for controlling cowpea weevil at a dose of 5ml/kg.

#43

RESEARCHES IN RESISTANCE OF THREE SPECIES OF GRAIN BEETLES TO PH, **Jiang Zhong-zhu Liu Xian-fu (Xiangtan Institute of Grain & Oil Science, Hunan 411100, China)**

We've determined the resistance of 42 series awaiting survey in 31 storehouses of 10 cities and prefectures in Hunan province. The subject makes it known that-Rust-red grain beetle [Cryptolestes ferrugineus (Stephens)] and Flat grain beetle [Cryptolestes pusillus (Schönherr)] had offered resistance to PH, especially Rust red grain beetles, it is scatlered wide) the resistance series are distributed over all the cities and prefectures in Hunan, amounting to 100% of the determined samples, in which the striking resistance made up 89.5%. By analysing the degree of resistance, we got to know that PH has lost its poisonousness to some series of the breed. The resistance series of flat grain beetle allounted for 70% of the determined of the breed. in it the striking resistance was 20%, and there are 2 most resistant series that we can't fix their LD value. Turkish grain beetle [Cryptolestes turcicus (Grouvilte)] is more sensitive. The resistance conditions of the three species of Grain beettes are:The sensitive series amount to 17.5%, the striking 55% and 27.5% are not serious.

#44

STUDY ON THE EFFICACY OF (CIS-TRNAS) CYPERMETH-a AGAINST SOME STORED PRODUCT PESTS. Ji-qi Gao (Grain and Oil Scientific Institute of City Tianjin), Zi-long Liu, Xiu-ying Ren, Min Wang (pujidao Grain Depot of City Tianjin)

Cypermethrin is a new promising pesticide. Experimental results showed that a concentration of 100 ppm applied to 5 stored product pest species, *Sitophilus zeamais*(M.), *Tribolium confusum*(J.), *Rhizopertha dominica*(F.), *Cryptolistes ferrugineus*(S.) and *Plodia interpunctella*(H.) could exterminate the eggs, larvae, pupae and adults. In practical work, 14 test-piles, total area 981 m^2 were sprayed with 100 ppm cypermethrin solution along with the stacked place leaving another 5 piles untreated. After the 3 summer months , no pests could be found in the test-piles, but a considerable amount of pests in the check-piles,

#45

RADIANT AND GENETIC EFFECTS OF ^{60}Co ON INDIAN MEAL MOTHS (PLODIA INTERPUNCTELLA). Chang-ju Yang, Zhi-hui Yang,Gan-ming Liu (Department of plant Protection, HuaZhong Agricultural University, WuHan 430070, China)

4 or 5-day-old male pupae of Indian meal moths were radiated by ^{60}Co at a dose of 1, 3, 5, 7, 10 kilo-rad. After the treatment, the males emerged from the treated pupae were mated with normal females. Obvious radiant effects were observed in the parental generation and progenies. The radiant effects were related to radiant dosage. Radiation affected the growth,development and reproduction of parents and progenies,and led to their deformity and death. A new strain with transparent wings appeared in F1 progenies after male pupae were radiated by ^{60}Co of 1, 5, 7 kilo-rad. Each of treatments resulted in partial genetic sterility in a certain degree. Considering the total effect of radiation, it is suitable to induce partial genetic sterility with ^{60}Co of 1-3 kilo-rad. Sex-ratio of every treatment became unbalanced and males were more than females, the ratio in ten families is approximately 2:1. It could be supposed that there are sex-Linked recessive lethal mutation in the families.

#46

STUDIES ON THE POPULATION DYNAMICS SIMULATION OF SITOPHILUS ZEAMAIS (MOT.) Qin-chun Zhang (Sichuan Grain Storage Institute, Ministry of Commerce, Chundu 610031, China)

The bionomics and ecology of experimental population of Sitophilus zeamais (Mot.) were studied. The development and population growth of S. zeamais are largely influenced by temperature and moistrue content of grain. The S. zeamais can grow under the temperature from 15-35℃, and moisture content from 10-20%. The optimal temperature is 28℃. This paper studied the innate capacity for increase (r) and stable age-distribution of S. zeamais under the six temperature and five moisture content. r is the greatest at 28℃.

We also studied the population dynamics and established the computer simulation model of S. zeamais. The computer model can better predict the occurrence of S. zeamais with the investigation in a store.

#47

EFFECT OF HIGH TEMPERATURES ON EGG-HATCHING OF TRIBOLIUM CASTANEUM AND T. CONFUSUM (COLEOPTERA: TENEBRIONIDAE). Yingjie Zhao (Department of Storaging Grain and Oil, Zhengzhou Grain College, Zhengzhou, Henan 450052, China)

The egg-hatching of Tribolium castaneum (Herbst) and T. confusum Jacquelin were studied in the lab under the conditions of high temperature (39-54℃) and 75% RH. The results showed: 1. At 39℃ the egg mortalities of both species were below 30% compared with control (30℃), but no difference at the exposed periods; 2. When temperatures were higher than 40℃, the resistance of T. castaneum to high heat was significantly stronger than that of T. confusum. At 42℃ the egg-hatching of T. castaneum was 59% and zero for T. confusum in 24 hr treatments; at 51℃, after 1 hours none of T. castaneum hatched and after 2 hrs. the same case for T. confusum; 3. The mortatity of new-born larvae at high temperatures (>40℃) was much higher than that of in the control.

#48

#49

HOUSE DUST MITES IN KOREA: CLASSIFICATION AND DISTRIBUTION. Baik Kee Cho (Department of Dermatiology, St. Mary's Hospital, Catholic University Medical College, 62 Yoido-Dong, Yongdeungpo-Ku, Seoul 150-010, Korea), Won Koo Lee (Department of Biology, Chonbuk National University, Chonju 560-756, Korea)

House dust mites were isolated and classified from dust samples collected from military barracks in the outskirts of Seoul and from 55 civil houses in Seoul and Chonju city through 1977-1979 and from house dust samples from 7 urban and 3 rural areas through 1981-1983.

The results were as follows:

1. Twenty-two species of mites belonging to18 Genera, to 10 Families, and to 3 Suborders were identified through the two times of collection.

2. *Dermatophagoides pteronyssinus* and *D. farinae* were found to be dominant species in Korea.

3. *D. pteronyssinus* occurred far more frequently in the samples from man's military barracks, but *D. farinae* were more frequent in woman's military barracks.

4. The average numbers of mite in unit dust samples (200 mg) from blanket, mattress and floor of the miltary barracks, and floor of civil houses were 114.5, 92.5, 43.4 and 17.9 respectively.

5. The occurrence rates of *Dermatophagoides* sp. in the urban areas were higher than those in the rural areas.

6. Number of house dust mites in unit samples was highest in August and then September, July, October and June in decreasing orders.

#50

#51

POSSIBLE DISTRIBUTION AND ESTABLISHMENT OF THE MELON FLY DACUS CUCURBITAE COQ. IN XINJIANG, CHINA. Jun Zhang (Hangzhou Animal and Plant Quarantine Service, Hangzhou 310021, China), Rui Gao (Urumqi Animal and Plant Quarantine Service, Urumqi 830011, China)

The Melon fly is a serious pest of various vegetable crops in south China but it is not known to occur in Xinjiang, China. The bioclimatic studies had been made to determine their possible distribution and establishment in these areas. The developmental zero and total effective temperature accumulation from egg to adult emergence were 10℃ and 650 day-degree, respectively. In Xinjiang, during the winter, from Nov. to March the temperatures drops to -10℃, the deep of soil freexing was at 43-115cm and fruit flies development activity are interrupted thereby. The favorable temperatures for the development and reproduction of fruit fly is from April to October..It seems that the fruit flies can not overwinter in these areas.

#52

THE INVESTIGATION ON MAIN STORED GRAIN MITES IN JILIN PROVINCE. Hui Li, Haihsiu Wang (JILin Cereals Oils and Foodstuffs Academy School, Changchun 130062, China)

We discussed many problems of main stored grain mites in this thesis, such as the species, the distribution, the economic significance and the emerging-frequency, the ecology and biology feature. 32 species of main stored grain mites were found in Jilin province, of which Typhodromas (Amblyseius) obtusus (C. L. Koch 1839) Sensu Hughes, 1961. Hypoaspis lubrico were recorded for the first time in our country. The list of distribution and infestation of main stored grain mites in Jilin province were established.

#53

A SURVEY ON TIBET STORED PRODUCT MITE FAUNA. Xiang-lin Shen (Department of Grain and Oil Storage, Zhengzhou Grain College, No. 140 Songshan Road,Zhengzhou 450052, Henan, China)

It is reported that the first survey on species and distribution and damage of stored product mites in Tibet from June to August, 1987. In this survey, the author discovered 39 species of stored product mites, including 9 new-record species and 16 damage several species, respectively. It is notice first that stored product mites respectively. It is notice first that stored product mites species existed in place with an elevation of 1700–4200 metre similar to the interior of our country, but these mites have been turned into a specific strain which can survive at cold hardness in dry atmosphere with less oxygen.

#54

STUDIES ON THE LIFE HISTORY OF THREE FLOUR MITES AND THEIR DAMAGE TO STORED GRAIAN AND FOOD. Chao-peng Shen (Sichuan Grain Storage Institute, Ministry of Commerce, Chengdu 610031, China)

Aleuroglyphus ovatus (Troupeau), Carpoglyphus lactis (L.) and Suidasia nesbitti Hughes belong to Acarida. They not only infest various stored product grain and food, but also cause acariasis in human. This paper studied the life-history of the three flour mites and their damage to stored grain and food and discussed the reletionship between life-history of the mites and their management.

#55
EXPERIMENTS IN LABORATORY ON CONTROLLING CHINESE COWPEA WEEVILS WITH MELIA AZEDARACH (Lin.) Yugang Zhang (Wugang Grain Bureau, Henan 462500, China), Yong-jia Jiang (Zhengzhou Grain College, Zhengzhou 450052, China)

The laboratory experiments of toxic action of oil, emulsion, powder dust of Melia azedarach (Lin.) on Chinese cowpea weevil larvae have been carried out. The results showed that the infestation by Chinese cowpea weevils could be effectively controlled for more than one year when treated with diluted M. azedarach (Lin.) oil by acetone at the concentration of 6ml/kg. All larvae of Chinese cowpea weevils could be killed with M. azedarach (Lin.) emulsion at the concentration of 1.6ml/kg, while the Chinese cowpea weevils could not be controlled with M. azedarach (Lin.) Powder dust.

#56
STUDIES ON CIRCULATING FUMIGATION ON SHIP VESSEL LOADED WHEAT IN BULK. You-lin Kang (Dalian Animal and Plant Quarantine Service, Dalian 116033, China)

It was difficult to fumigate thoroughly on ship vessel loaded wheat in bulk owing to a compact density was found on the long way of voyage.This paper reports a fumigating technique consisting of fanning blower, pipelines, valves, etc. to enchance the penetration of the fumigant into the deep layer of the ship vessel. Seven practical trials with methyl bromide showed that the technique is feasible. It is effective not noly adequate under low temperature but also time saving.

#57
A STUDY ON THE INTERCEPTIONS OF INSECT PESTS IN THE QUARNTINE OF THE EFFECTS OF PASSENGERS ON CHONGQING AIRPORT . Xin－pei Jiang (Chongqing Animal and Plant Quarantine Service , Chongqing , 630020 China)

This paper deals with the interception of insect pests in the quarantine of the effects of passengers entering China on Chongqing Airport during the last five years . There were 2 quarantine pests . i.e. *Sternochetus mangiferae* (Febricius) and *Dacus cucurbitae* (Coquillett), and 25 injurious pests found in the effects carried by the entering passengers.

#58
QUARANTINE OF INSECT VECTORS TO PREVENT SPREADING OF PLANT DISEASES. Cong-zhong Zhang, Yue Cai (Institute of Plant Quarantine, Ministry of Agriculture, Beijing 100026 , China)

Ten insect-borne plant diseases, are listed in the Lists of Plant Quarantine Objects issued by Chinese government in 1986. They are: Pine Wilt Disease, Red Ring Disease of Coconut Palm, Qak Wilt, Elm Wilt, Fire Blight of Pear, Bacterial Wilt of Corn, Cacao Swollen Shoot Disease, Coconut Palm Lethal Yellowing, Potato Yellow Dwarf Virus and Soybean Mild Mosaic Virus. In the present paper, insect vectors responsible for spreading these 10 plant diseases, and on analysis and evaluation of their quarantine importance are given.

#59
INJURIOUS BEETLES INTERCEPTED IN IMPORTED STORED PRODUCTS DURING 1985-1990. Yong-ping Liu (Institute of Plant Quarantine, Ministry of Agriculture, Beijing 100026, China)

About 100 beetle species were found in samples of stored products entering China from several portal quarantine services. The species of the family *Dermestidae* and *Bruchidae*, the most important for plant quarantine, are listed. Judging from their economic importance and settlement possibility, the invasion of *Trogoderma granarium* Everts and *Acanthoscelides obtectus* (Say) must be given the strictest surveilance.

#60
INSECT PESTS CAPTURED FROM THE IMPORTED WOODEN-PACKING MATERIAL. Jin-fu Wang, Guang-cai Liang (Guang Zhou Animal and Plant Quarantine Service, Guang Zhou 510010, China)

The wooden-packing material(WPH) is an important source of insect pests in the international trading activity. Quarantine on the WPM carring non-planting cargoes has long been neglected. For seeking a way to prevent important economic insect pests from being carried into China, a series of survey of the WPM have been done for a couple of years according to the inspection on the WPM from 21 countries and regions, 44 species of insect pests belonging to 4 orders have been found. Among them 77% were forest insects, 16% were stored product insects.

Because of the WPMs are widely used to carried any kinds of cargoes and as such can carry many kinds of insect, inspection to them is necessary.

#61

REPORTS ON CAPTURING AND EXTERMINATING THE FALL WEBWORM(*Hyphantria cunea* Drury). Jin-fu Wang and Quang-Lai Liang(Shouguan Animal and Plant Quarantine Service, Shouguan 510010, China)

On Jan. 1991, more than 300 pupae of the fall webworm were found harboured in the inner lining of wooden case imported from Hungary. The cargo itself is non-plant material, namely, mechine tool, the wooden case is lined with one layer of pitch paper and one layer of plastic membrane, and the pupae were found between these two layers, the density is about 30 pupae/m^3. We took the following measures to exterminate this pests: (1). burn out the inner limings harbouring the pupae and all questionable things, (2). fumigate the wooden case along with the machine tool with methyl bromide at 65g/m^3 for 5 days. (3). spray the place where the cargo was stacked with Decis at 1:3000.

#62

NOTES ON PLANT QUARANTINE AND URBAN ENTOMOLOGY. Ji Cao(Chinese Academy of Agricultural Sciences, Beijing 100081, China)

Generally speaking, plant quarantine is primarily concerned with agricultural entomology.Nevertheless, it is getting more and more related to urban entomology. As a consequence of social urbanization, the importance of plant quarantine to citizen life should not be overlooked. The oriental cockroach, *Blatta orientalis*, is said to settle at the east coast of North America as early as 1758. Being controlled by its egg parasites, it remained unimportant for ages. In early 1980s, however, it suddenly appeared in Miami free of any parasite. The weather condition there enhanced its reproduction and propagation. Now it is a noxious species all over Florida. Many European countries put quarantine on this pest.

The gypsy moth, *Porthetria dispar*, is another exotic pest of North America. In 1869, the insect was deliberately imported from Europe into Boston as a possible producer of silk. It spread to many eastern states by 1905s. In epidemic years, the foliage of various shade trees was eaten up and winter conditions occured at summer time. The starved caterpillar would crawl everywhere even into houses. Although it was once controlled by DDT, but the problem is far from being solved and plant quarantine measures might still be needed for newly-developed cities.

#63

STUDY ON ERADICATING TECHNIQUE FOR TREE SEED PESTS WITH MICROWAVES. Bu-qu Gao, et al. (The General Station of Forest Pest and Diseade Control, Ministry of Forestry, 58 Northern Huanghe st., Shenyang 110031, China)

Larix gmelini seeds with *Eurytoma laricis*, *Pistacia chinensis* seeds with *Eurytoma plotnikovi*, *Amorpha fruticosa* seeds with *Acanthoscelides plagiatus*, *Robinia pseudoacacia* seeds with *Bruchophagus philorobiniae*, *Cryptomeria fortunei* seeds with *Megesligmus cryptomeriae*, *Caragana microphylla* seeds with *Kytorrhinus immixtus*, and *Gleditsia tricanthos* seeds with *Bruchidius dorsalis* about 1-1.5 kg each were treated respectively in a microwave oven(type ER-692/WMO-5) at 60°c for 1-3 minutes. A 100% kill of both larvae and pupa of *Eurytoma laricis*, *E. plotnikovi*, *Acanthoscelides plagiatus*, *Bruchophagus philorobiniae*, *Megesligmus crypto-meriae*, *Kytorrhimus immixtus*, and *Bruchidius dorsalis* was obtained.

The effect of microwaves on germination of seeds varied with the temperature, the duration of treatment, and the kinds of seeds, when it was below 65°c for 5 minutes, the effect on germination of seeds was not evident; but when over 70°c for 1-5 minutes, a detrimental effect on seed germination was distinct.

#64

WATER PRESERVE METHOD FOR ERADICATING TIMBER PESTS. Si-lin Tao (The General Station of Forest Pest and Disease Control, Ministry of Forestry, 58 Northern Huanghe st., Shenyang 110031, China)

The present paper gives the result of a probit analysis of the water preserve method for eradicating the timber pest, *Orthotomicus erosus* Wollaston. The analysis demonstrated that keeping the timber completely in water was the best method for eradicating the timber pest, spraying pesticide contemporarily on the surface of the timber floating above the water level would increase pest mortality. The life stage of the pest and the treatment duration affected the result of this method, but it did not show significant correlation with the temperature of the water and the weather condition. Comparing with chemical sealing or fumigation on ground, it needs less labour cost and is more economical.

#65

OCCURRENCE AND CONTROL OF *CYLAS FORMICARIUS* ELEGANTULUS (Summers) IN JIANGXI. Ji Ou-yang (Plant Protection and Quarantine Station of Jiangxi Province, Nanchang, China)

Sweetpotato weevil,*Cylas formicarius* elegan-tulus (Summers) has 4 to 5 overlapping generations per year in Jiangxi, the winter being survived in the stages of adult,pupa or larva. Overwintering adults became active at the end of March to early April, while the overwintering pupae and larvae emerge in succession in the second and last ten days of April. It mainly infests sweet potato. The yield was decreased by 15% generally to 50% high. The infested tubers became black, foul and bitter and could not be eaten.

Sweetpotato weevil is a pest of latitude. So far it occurred only south of 27° N in Jiangxi.

Control of sweetpotato weevil are conducted by (1) establishing pest-free seed beds which are served as supplying bases of sweetpotato seedlings; (2) fumigating infested tubers of seedlings with methyl bromide or soaking seedlings in organic phosphorous insecticide solutions to prevent its spreading; (3) enhancing field control, including overwintering pest elimination, crop rotation, good field management and insecticide spraying.

#66

A STUDY ON QUARANTINE OF HETEROBOSTRYCHUS AEQUALIS. Zhi-lin Chen (Shenzhen Animal and plant Quarantine Service, Shenzhen 518001, China).

Heterobostrychus aequalis (waterhouse) is a tropical and subtropical wood insect, finding the insects in importing rattans and wooden box from Indonesia and Thailand frequently. Its damaged the rubber on glass windows which holding the glass along outer walls at constructing Shenzhen Developing Central Building in June 1988, also its damaged rattans seriously at Donguan Shipai Rattan Factory in septemer 1988. Observing characters of adult, egg, larva and pupa, we found distinguishable characters. Life period in Shenzhen has one generation a year, adults live through the winter and start to lay eggs in May, 13 days in eggs, 56 days in larvae and 15 days in pupae. Effective method of Quarantine: Scraps of wood and rattan that insect damaged should be checked with attention in period of adults and listening sound of knock using hammer on wood, distinguishing tenacity on rattan in period of larvae and pupae. Fumigation control: Methyl bromide 30-40g/m^3, duration 24 hours; Phostoxin 15-20g/m^3, duration 72 hours; or Sulphur 250g/m^3, duration 24 hours after firing up.

#67
STUDY ON LIVING CHARACTERISTICS AND CONTROL MEASURES OF COFFEE BERRY BORER. Jiyong Li, Juan Lin (Haikou Animal and Plant Quarantine Serviec, Haikou 570011, China)

Coffee Berry Borer(*Hypothenmus hampei*) had not been found on coffee in Haikou coffee plantation until recently. It needs 27 days that coffee berry borer accomplished one generation when it was bred in the laboratory. The duration of eggs, larvae and pre-pupae was 5.5, 16.3 and 2 days respectively. The female lay 4-8 eggs each time, at most 12 eggs. The male is scarcely seen; it lives only in the fruits of coffee. The sex ratio of born was found to be 13:1. The growth of larvae seemed to be affected by the water in the coffee fruits. The control measures are as follow: (1) to strengthen the quarantine inspection and approval of importing coffee seed and limit the amounts to avoid importing seed from causing epidemics. (2) to inspect strictly the coffee seed and the seed of related plants arriving at the port. (3) to fumigate the coffee seed with coffee berry borers using 8-10g/m^3 aluminum phosphate or 60-65g/m^3 methyl bromide for 48 hours. The killing effect was 100%.

#68
A STUDY OF CHANGING NOMENCLATURE OF RICE WEEVIL AND THEIR IDENTIFICATION. Yong-jing Xu (Dalian Animal and Plant Quarantine Service, Dalian 116001, China)

The paper presents the distribution and the morphological identification of rice weevil(*S. zeamail* Motschusky), meanwhile the changing of systematic nomenclature of the two weevils are discussed.

#69
PRELIMINARY OBSERVATIONS OF LIVING HABITS OF *ATTAGENUS GLORIOSAE*(Fab.). Yong-jing Xu (Dalian Animal and Plant Quarantine Service, Dalian 116001, China)

The living habits of *Attagenus gloriosae*(Fab.) whose larvae can do harm to the substance of various plants and animals have never been reported in our country. Some records about its distribution can be found only in a few districts.

It was in 1978 that we first detected the adults and larvae from some imported products of plants and animals. From 1978 to 1984 we reared them in the laboratory under room temperature, it was found that each generation lasted from 344 to 1527 days, the larval stage took 321-1499 days, and remained in this stage during the winter in Dalian district.

#70
STUDY ON INSECT PESTS OF CHINESE LOCAL CHESTNUT (*Castanea mollissima*) AND ITS QUARANTINE. Rong-feng Zhang(Agriculture and Forestry Bureau of Shangyu County, Zhejiang Provence 312300, China, Ximin Chai(Forestry Institute of Zhejiang Province), Hong Wu(Zhejiang Forestry College).

This paper records 337 species of insect pests harmful to Chinese Chestnut, including their Chinese and scientific names, their distribution, host range ahd present quarantine status. For those most harmful species, the trend of their annual incidence and their quarantine significance were studied separately. It showed that *Characama ruficrra* Hampson and *Asterolecanium Castaneae* Russel are two most dangerous pests. Further study seems necessary befor we can make scientific suggestion to treat them as forest plant quarantine objects in some territory in China.

#71
A SURVEY OF BEETLES OF STORED PRODUCTS CAPTURED FROM BURMA CARGOES . Xiao-long Jiang, Li-bin Zhou, Chan-guo Xia(Kunming Animal and Plant Quarantine Service, Yunnan 650034, China)

Beetles infesting stored products were captured in some animal and plant products imported from Burma in 1983-1989. Hundred and twelve species belonging to 25 Families have been identified. Of them, there are 4 quarantine pests, namely, *Trogoderma granarium, Acanthosscelides obtectus, Zabrotes subfasciatus, Pachymerus gonagra*, 4 dangerous pests and 16 species new to China. This paper gives the species, products found, location collected and frequency of infestation.

#72
ON THE ESSENCE OF PLANT QUARANTINE. Ji Cao (Chinese Academy of Agricultural Sciences, Beijing 100081, China)

All living organism is bestowed with the ability of self-expansion. Growth is expansive, and reproduction is even more so. One may say that the more expansive a species is, the fittest it is also. Man is a paramount exemple, next come those species which have whole or part of their life linked with man, and those live on plants, plant product or even soil are of plant quarantine significance, although their per se ability of expansion is low, they had conquered vast area of new territory simply by hitchhicking. Wherever there is trading of plant material, there is a chance for their invasion into new territory. It is on this dilemma lies the difficulty of plant quarantine.

Strengthening of plant quarantine must be done on a world-wide basis. It is suggested that: (1) the quarantine service of FAO should be authorized to function as a headquater of fighting against quarantine pests. She should be equipped with computerized network of intormation on those pests; (2) in developed contries, attempts should be made to unify plant quarantine (front line) and plant protection (rear line).

#73

STUDY ON VACUUM FUMIGATION TECHNIQUE FOR TREE SEED PESTS. Bu-gu Gao, et al (The General Station of Forest Pest and Disease Control, Ministry of Forestry, 58 Northern Huanghe st., Shenyang 110031, China)

Larix gmelini seeds with *Eurytoma Laricis*, *Caragana microphylla* seeds with *Kytorrhinus immixtus*, *Amorpha fruticosa* seeds with *Acanthoscelides plagiatus*, *Robinia pseudoacacia* seeds with *Bruchophagus philorobiniae*, *Cryptomeria fortunei* seeds with *Megesligmus cryptomeriae*, and *Gleditsia sinensis* seeds with *Bruchidius dorsalis* were treated respectively at 15-19°c and 730-740 mmHg vacuum in a fumigator (type zx-350), using 50g/m^3 dose of CH_3Br/SO_2F_2 for 3 hours, 100% larvae of *Eurytoma Laricis*, *Bruchophagus philorobiniae*, and *Megesligmus cryptomeriae* in seeds were killed. Using 60g/m^3 dose of CH_3Br/SO_2F_2 for 3hr., 100% larvae of *Acanthoscelides plagiatus*, *Kytorrhinus immixtus*, and *Bruchidius dorsalis* in seeds were killed. There is no evident detriment to germination of seeds. With the same dosage of fumigants at 32-34°C, The fumigation time was shortened, but the germination rate of seeds was much reduced. The side effect of repeated fumigation at 15-19°C on germination of seeds is not evident; but that at 32-34°C is distinct.

#74

A STUDY ON THE PINE SHOOT BEETLE BLASTOPHAGUS PINIPERDA L. (COLEOPTERA: SCOLYTIDAE). Mo-qi Li, Ji-zhang Ja (Animal and Plant Quarantine Institute of Longkou City, China)

It is confirmed that the Blastophagus piniperda had been dispersed all over Yantai City through the observations made in the fixed positions and the laboratory rearings. It's main morphological characteristics are follows: there are 10 stripe ranks composed of cutting spots on it's elytrum and scattered granules between the ranks which accompanized by villi, the second trench on elytrum is clearace and depressed slopingly. It has one generation per year in Yantai City. Adult overwinters in the bark of the base trunk at the end of September. The tunnel of parents is parallels to the trunk and is vertical with that of offspring. One male and one female make a tunnel in common which has a matting chamber in it. Female mates many time in its life and oviposits while the building of tunnel. Female enters the wood from the invasion hole successively and oviposits in good orders, and eggs hatch successively. Each tunnel contend 30 to 60 eggs. The oviposition period is 9 days. The larvae build a offspring tunnel when it's eating. There are 5 instars in larvae which takes about 30 days, and pupation at the end of the offspring tunnel. The duration of pupa is 10-13 days. Pupae emerge in later May, and the adults harm the new tree-top till the end of September.

A PRELIMINARY STUDIES ON SOME THRIPS AND A FEW REMARKS UPON QUARANTINE. Yun-fa Han (Institute of zoology, Academia sinica Beijing 100080, China)

This paper presents the importance, plants attacked, distribution, life history, appearance, habits, dissemination and quarantine measures of 3 species of thrips: Scirtothrips aurantii, S. citri and Taeniothrips inconsequn, as well as the intercepting practice of plant quarantine in some foreign coutries. The author suggested that S. citri should be put in the list of quarantine pests.

Soil application of 3% carbofuran granules was effective to control the Thrips and other sucking pests.

THE EXPERIMENT OF CONTROL OF RED ANTS BY ANTCIDES. Gan Wu, Pei Hu (Sanitation & Anti-epidemic Station of Liaoyang Petrochemical Fibre Company, Liaoyang 111003, China)

The experiment on control of red ants by Antcides are conducted at 65 buildings of the Company's living region. The results showed that Antcides against red ants was at 86% of killing rate. The authors introduced this new antcides and discussed eliminating methods of red ants in present paper.

Rice Water Weevil Distributing in Asia Is a New Species. Guan Lianghua (Tianjin APQ 300456) Huang Fusheng, Lu Baolian (Zoo. Ins. Acad. Sinica, Beijing 100080)

Lissorhoptrus pseudooryzophilus L. H. Guan, F. S. Huang et B. L. Lu is a new species. After observations on specimens from Japan, Korea comparing with type species from USNM and specimens from US, Canada we found many different characters between them. But the main differences are:

1.The big black maculation on elytra of new species is much conspicuous than that of L. oryzophilus. 2.New species female with about 400μ length of duct of spermatheca but that of L. oryzophilus only has 160μ length of spermatheca duct. 3.Rod-like sternite of new species's female genitalia system with rod-like end which has width 135μ; L. oryzophilus has rod-like sternite with axe-like end 220μ big. 4.New species distributes in Asia, another is in America. 5.New species is parthenogenesis but another is normal.

TOXICITY OF CHLOROPYRIFOS—METHYL AND DELTAMETHRIN COMBINATIONS TO THREE SPECIES OF STORED GRAIN INSECTS. Xien—chang Tan, (Chengdu Grain Storage Research Institute, Ministry of Commerce; Chengdu, 610031, China)

In lab; wheat was treated with a series concentrations Chloropyrifos—Me and Deltamethrin (with 10 times Piperonyll butoxide W/W) combinations in a ratio of 0 : 2, 10 : 1, 10 : 0.5, 10 : 0.2, 10 : 0.1, 10 : 0.05 & 10 : 0, their taxicity to ***Sitophilus zeamais*** (Mots.), ***Rhizopertha dominica*** (F.) & ***Tribolium castaneum*** (Hbst.) were determined.

Results showed that, for complete control of ***S. zeamais*** (no F_1 & F_2 progenies) concentration of Chloropyrifos—Me must be more than 1ppm, for ***T. Castaneum*** must be more than 0.5ppm, under tested concentrations toxicity of Deltamethrin was not significant. For ***R. dominica*** (resistant & sensitive strains) concetrations of Deltamethrin must be more than 0.025ppm in any ratio of combinations.

Minimum effective doses for against three insects were 1ppm for 10 : 0.5 ratio, 2ppm for 10 : 0.2 & 5 ppm for 10 : 0.1, among them there was a minimum economic effective dose depandent upon the prices of both insecticides.

INVESTIGATION OF MITES OF STORING GOODS IN HEILONGJIANG. Shuxiao Du, Haifeng Zhou, Jinfeng Ju, Jiale Hong (Heilongjiang Provincial Grains and Oils Storage and Transportation Company, No. 77, Nanma Road, Harbin 150020, China)

From 1986 to 1989, we investigated mites mainly in grain store house, grain processing factories and oils processing factories, also, in forage factories, foods factories, pickls factories, tranditional chinese medicine storehouse, leather factories, wine processing factories. resident house etc. in our Province. According to the topography of higher north and lower east, and cold winter and warm summer of middle temperate zone, and monsoon geographical climat. we choose ten investigation regions. They are harbin, Acheng, Bayan, Suihua, Tailai, Fujin, Dongning, Yichun, Heihe, Daxing anling, total 248 units. We found mites belonging to six orders, thirteen families, nineteen genera, total twenty-six species. The writer studied the distribution of the mites. According to frequency and density of the mites, and the prevalent species, target mites, the geographical and environmental conditions of the habitat of the mites and relation of mites with human being activity were determined. The results showed at cold north region in our country, mites cause great damage to the storing goods.

STUDIES ON WOOD INFESTING INSECTS IN ZHEJIANG PROVINCE. Xi-min Chai, Zhi-hua He (Zhejiang Forestry Institute, Hangzhou 310023, China)

A survey of wood infesting insects was conducted at 6 timber productive districts in Zhejiang province. 33 species which belong to Coleoptera, Hymenoptera and Homoptera were found on the logs of Masson's pine Pinus massoniana, Chinese fir Cunninghamia lanceolata, the oak etc., in which 15 of them were cerambycids, 13 scolytids, 2 weevils, one buprestid, one horntail and one bostrichid. There were more wood infesting insects in the Masson's pine logs than in the Chinese fir, and the damages caused by them were also more serious in the former one. Cerambycids can make enormous economic losses of timber in Zhejiang province.

TRAPPING GRANARY WEEVIL SITOPHILUS GRANARIUS WITH VEGETABLE OILS AND PHEROMONE. Xiao-long Jiang, (Kunming Animal & Plant Quarantine Service, Yunnan 650034,China), W.E. Burkholder, J.K. Phillips (Stored Product & Household Insect Lab. ARS, USDA, Dept. of Entomology, University of Wisconsin, WI 53706,U.S.A.)

Pheromone and edible oils were tested for their efficacy in attracting adults of Sitophilus granarius released in lots of 100 into a baking tray containing 1kg of wheat. The oils of wheat germ, Energol, oat were attractive when compared with mineral oil. Granary weevils preferred the (R*.S*)-1-ethylpropyl 2-methyl-3- hydroxypentanoate to hexane, but high concentration reduce the attraction. In corrugated cardboard trap test, the attraction of pheromone combined with wheat germ oil or oat oil is superior to pheromone or oil alone.

SURVEY ON STORED PRODUCT PESTS AND THEIR CHEMICAL CONTROL. Rong-chang Zhou (Hengyang Grain Training School, Hengyang, Hunan 421101, China)

A survey on the insect pests of stored products has been carried out at seventy storehouses in Hengyang. There are 68 species belonging to 33 families, 10 orders. The major pests are as follows: Sitophilus zeamais, Rhyzopertha dominica, Cryptolestes pusillus, Oryzaephilus surinamensis, Tribolium castaneum, T. confusum, Callosobruchus chinensis, Bruchus pisorum, B. rufimanus, Alphitobius laevigatus, sitotroga cerealella. Their distributions, popnlation densities and damage degrees were surveyed. Not only the stored grain but also the stored plant products may be caused large economic lossed by them. To control those stored pests, we have taken following measures: (1) to sterilize the empty storehouses with DDVP or fumigation agents. (2) to control those pests with the aluminium phosphate by different allied methods in storehouses. The applied methods and the effections of aluminium phosphate which compared each other were observed. The results showed that it is better measures to stilize the empty storehouses with fumigation agents and to control pests with aluminium phosphate by a vessel to put in.

USE OF METHYL BROMIDE TO FUMIGATE AIRPLANES. **Ren-zan Tan, Yun-han Chen, Jian-hua Zhou, Bo-en Ou, Xiao-wen Li, Long-fei Hu** (Department of Vector Control, Guangzhou Health and Quarantine Bureau of the Guangzhou 510700, China)

Methyl bromide is a fumigant widely used in storehouses and ships for pest control. As the increasing strict sanitary supervision to air transport internationally and the lack of suitable methods for deration and disinsection in airplanes, we studied the fumigation to airplanes using methyl bromide as the fumigant. 19 passenger airplanes were fumigated during July to October, 1989. Airplanes were fumigated airproofly for 6-11 hrs. under a dosage of $15g/m^3$. Of all the tested animals in 10 airplanes, the minimum lethal time of white mice and cockroachs, *Blattella germanica* (L.), were the same, 120 minutes, and the maximum of those were 380 and 550 minutes respectively. No fumigant residue was tested positive after opening all the airplane exits for 1-3 hrs. by varieties of the airplane and the climate. The result showes the killing rate of cockroachs in each of the 19 airplanes was 100% (density test). No adverse effects to human was reported and no related damages to any equipment of the airplanes was found during a 2 years' survey for the related population and 38 fumigated passenger airplanes from 1989 to 1991. Also, the cost-efficiency of the method was studied. The method using methyl bromide for fumigation costed 50% less than that of the others did. The result showes that the fumigation is a rapid, safe, economical and effective method for derating and disinsection to airplanes and is worthy of utilization.

INTRODUCTION: AN OVERVIEW OF THE SERICULTURAL SCIENCE FACING THE 21TH CENTURY. **Hong-Sheng Lu** (Chinese Academy of Agricultural Sciences, Beijing 100081, China)

Some frontiers or exciting areas of current sericological researches may be pointed out as followings: (1) Molecular basis for silk production and feasibility for improving silk yields in silkworm by genetic engineering. (2) Construction of a high density molecular linkage map for the silkworm and toward transgenic silkworm. (3) Genetical control of silkworm sex, increasing silk production by rearing male individuals only. (4) Endocrinological basis of silkworm growth and development, regulation of silk production, silk size,and disease resistance by insect hormones. (5) Nutritional physiology and artificial diet of the silkworm, breeding of polyphagous silkworm races and rearing it all the year round in the mechanized plants by low-cost artificial diet. (6) Silkworm pathology, ecology, rearing technology, and stabilization of the cocoon yields. (7)Multipurpose utilization of silkworm biological resources and development of new textile from silk. (8) Solution of specific problems in development of tropical sericulture, such as breeding of silkworm races with high tolerance of climatic stressors, resistance to infections and nice silk qualities. (9) Silkworm as a minifermentation vessel producing rDNA proteins, high level expression of foreign genes in silkworm using baculivirus vector. (10) Silkworm as a research model for solution the basic problems both in classical and in molecular biology.

we would summarize the advance on these sericological researches up to date and discuss what to do in coming years by 2000 on the symposia and workshops of this section.

EXPRESSION OF FOREIGN GENES IN SILKWORM USING THE BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS VECTOR. S. Maeda (Department of Entomology, University of California, Davis, CA 95616, U.S.A.)

The Bombyx mori nuclear polyhedrosis virus (BmNPV) and silkworm have been used effectively for basic research and its applications in medicine and agriculture. BmNPV has a unique advantage of having a physiologically and biochemically well studied larval host, the silkworm, B. mori. Various expression transfer vectors are available for this system possessing specific advantages including: 1) multiple cloning sites with the complete 5' non-translated sequence upstream of the polyhedrin gene for high level expression, 2) the 5' coding sequence of polyhedrin for expression of polyhedrin-fused proteins, and 3) a lacZ color selection marker for simplified isolation of recombinant virus. Based on various expression experiments, the BmNPV expression system exhibits the following characteristics: 1) most genes are expressed at higher rates in vivo, (in the silkworm), than in vitro (in the BmN cell line); 2) genes encoding secreted polypeptides are expressed significantly higher in the silkworm (up to 1000 fold higher); 3) fusion proteins fused to the polyhedrin N-terminus are also highly expressed in larvae and in BmN; 4) expressed polypeptides generally possess biological, enzymatic, and antigenic characteristics similar to those of the authentic polypeptides.

Molecular Basis for the Silk Production in Bombyx mori

Yoshiaki Suzuki
National Institute for Basic Biology
Okazaki 444, Japan

Since 1968 my effort together with many of my colleagues has been concentrated on deciphering of the molecular mechanisms that control the silk gland development and the silk genes expression in Bombyx mori; purely "basic" in motivation and almost negligible for the intention of "applied". Some knowledge produced in this field, however, should naturally be useful when we consider an improvement of the silk production in the future. Therefore, I would summarize how the molecular analyses in the silk gland system in B. mori became possible as early as 1970 when the mRNA for silk fibroin was discovered, what we know by 1992 on the molecular basis of the silk gland development and the silk genes expression, and what we are trying to understand in coming years by 1999.

MOLECULAR BIOLOGY OF SILKMOTH CHORION GENES. J. Drevet, L. Swevers, Y. Skeiky and K. Iatrou. Department of Medical Biochemistry, University of Calgary, Canada.

Our studies focus on the analysis of events that underline the establishment of the choriogenic program in follicular cells during silkmoth oogenesis and the identification of factors that mediate the implementation of this program through the regulated transcriptional activation of chorion genes. Long-term organ culturing of isolated ovaries has revealed that the choriogenic potential becomes established in vitellogenic follicles 2.5 days prior to the onset of choriogenesis and that this potential can be implemented autonomously in the absence of extra-ovarian factors. We are now in the process of identifying components of the regulatory cascade that operates during mid-vitellogenesis in an effort to understand how implementation of the choriogenic program takes place. Our studies on the characterization of transcription factors that control the stage-specific activation of chorion genes have revealed that one of them, BCFI, contains a zinc finger DNA-binding domain similar to those characteristic of the GATA-1 factors which regulate expression of specific genes in mammalian and avian erythroid cell lineages. These studies have also shown that BCFI is regulated post-transcriptionally by alternative splicing generating two isoforms, both of which can bind DNA and post-translationally by differential cellular compartmentalization. A modified form of BCFI is present in the cytoplasm but not in the nucleus of vitellogenic, early and middle choriogenic follicular cells. BCFI is recruited into the nucleus of follicular cells during late choriogenesis,the time of activation of its target genes, through a process that involves reversal of the cytoplasmic modification.

RECENT PROGRESS OF LINKAGE ANALYSIS IN *BOMBYX MORI*.
Hiroshi Doira (Institute of Genetic Resources, Faculty of Agriculture, Kyushu University, Hakozaki, Higashi-ku, Fukuoka 812, Japan)

Linkage phenomenon in the domesticated silkworm, *Bombyx mori*, was firstly discovered by Tanaka in 1913. Most of genetic researches with *B. mori* in the earlier half of this century had dealt with the isolation and characterization of morphological characters. In recent years much attention has been concentrated on the genetic control of physiological, pathological, behavioral, biochemical and molecular traits. The expected number of linkage groups is as many as twenty-eight, such a large number of chromosomes makes linkage between any two genes rather unlikely. Recombination of linked genes takes place only in the homogametic male sex, absence of crossing over in females results in special segregation pattern between linked characters that makes it easy to judge whether the genes in question are linked or independent of each other. In 1986, distribution of 190 gene loci among 25 linkage groups was demonstrated. Five years have passed, and the current linkage maps provides 210 gene loci and genetic maps are available for two more linkage groups. The remaining one requires further studies, though it is already represented by a marker gene which has been proved to be independent of the hitherto been established linkage groups. Recent studies have revealed several spontaneous mutations are accompanied with chromosomal attachments of Robertson type having extraordinary large size, the number of chromosome are decreased to 27 pairs. Holokinetic nature of the chromosomes of this species might have allowed stable transmission of such abnormalities.

CHARACTERISTICS OF "GIANT EGG" MUTANT OF *BOMBYX MORI* AND INDUCTION OF LARGE EGGS BY APPLICATION OF 20-HYDROXYECDYSONE.
Yutaka Kawaguchi, Yutaka Banno, Katsumi Koga, Hiroshi Fujii, Hiroshi Doira (Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

The "Giant egg" (*Ge*, 1-14.0) mutant was characterized in detail. The size of *Ge* egg based on measurements of the major and minor axes was larger than that of the normal egg by 1.18 and 1.12 times, respectively. The weight of an egg was 1.44 times heavier in *Ge* than in normal. The eggs produced by a *Ge* female was 33% fewer in number than those produced by a normal female. The *Ge* egg contained 1.53 times more yolk proteins than the normal egg, although with no qualitative differences.

On the other hand, injection of large amounts of 20-hydroxyecdysone into normal female pupae altered egg production. In addition to normal-sized eggs, large eggs were produced, which resembled the *Ge* eggs in size and weight. Yolk proteins in these eggs had almost the same abundance as those in the *Ge* eggs. The enlarged eggs were distributed in an ovaliole not at random but clustered within a definite region.

GENETIC STUDIES ON THE RELATIONSHIP BETWEEN BROWM-SPOTTED CALTROP AND CALTROP-TYPE MULTILUNAR. Zhonghuai Xiang, Cheng Lu, Yihong Shen (Academic Unit of Silkworm Genetics, Southwest Agricultural University, Chongqing 630716, China)

The brown-spotted Caltrop mutation was discovered in the Research Laboratory of Silkworm Genetics, Southwest Agricultural University.

A study with the methods in experimental genetics showed that the gene L^{ca} is dominant over the gene L^{c}. the dominance in the L multiple alleles appeared in the order of $L^{ca} > L^{c} > L > +^{L}$. As in the case for L^{c}/L^{c}, L^{ca}/L^{ca} is lethal. On the other hand, L^{ca}/L^{c} is not lethal. Thus, L^{ca} and L^{c} show complementation in term of gene lethal effect and the L gene group may be regarded as a "pseudoallelic group".

A GENETIC STUDY OF RECESSIVE GREY IN SILKWORM (BOMBYX MORI L.). Zhonghuai Xiang, Cheng Lu (Academic Unit of Silkworm Genetics, Southwes Agricultural University, Chongqing 630716, China)

Recessive grey egg, a new spontaneous mutant of silkworm, has been discovered and studied in the Academic Unit of Silkworm Genetics, Southwest Agricultural Univertsity. The egg is grey white in color with two or three longitudinal channels milky white. Genetically, the mutant is recessive to $+^{gr-r}$. It is the only recessive grey egg hitherto dicovered in silkworm, different from all the other grey eggs: Gr, Gr^{16}, Gr^{B}, Gr^{X-1}, Gr^{X-2}, Gr^{L}, Gr^{Z} and Gr^{K}. It has been, therefore, named recessive grey egg and designated gr-r. An investigation of linkage with the methods used in experimental genetics has shown that gr-r is independent of lem (3), L(4), E^{ca}(6), K (11), Ng(12), ch(13), Bm(17) or Nd (25) in inheritance and is linked to P^{m}(2), that is to say, gr-r is located in the second linkage group. A three-point experiment localized gr-r at 7.5 in the second linkage group, viz. 2-7.5.

PROGRESSES OF SILKWORM GERMPLASM RESOURCE RESEARCH IN CHINA Qin Jian, Wenzhong Yi (The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang 212018, China)

Silkworm germplasm resources are the bases to develop sericulture. The article has given in a general way, the researches and the achivements in silkworm germplasm resources in recent years in China. The present problems and the future of the silkworm germplasm resource research are discussed.

CYTOGENETICAL STUDIES ON ERI-SILKWORM (PHILOSAMIA CYNTHIA RICINI)
Fangzhou Song, Zhonghuai Xiang, Shaolan Liu
(Academic Unit of Silkworm Genetics, Southwest Agricultural University, Chongqing 630716, China)

Examination of the chromosomes of lepidoptera insects is easily distinguishable, exact and reliable at the diplotene stage of meiosis since the chromosomes take on the long narrow configuration and homologous chromosomes are parallel to each other in arrangement. In this experiment the chromosome number and sex type of eri-silkworms were studied at the diplotene stage. Thirteen pairs of parallel bivalents and one free univalent were observed for females and 14 pairs of bivalents were observed for the males at metaphase I. Thus, the chromosome number for female and male eri-silkworms is thought to be XX-XO (ZZ-ZO), not XX-XY. The univalent noticed at the diplotene stage is presumably the sex (X) chromosome.

It was observed that the univlent of female eri-silkworms at the diplotene stage twists and folds and partially self-pairs, thus forming a variety of "hairpin-like" configuraton. This is the first report of such a phenomenon in lepidoptera as well as in eri-silkworms and may be of importance for the study of the origin and evolution of the sex chromosome.

STUDIES ON HEREDITARY VARIATION IN DOMESTIC SILKWORM BY INDUCING DNA OF SILKWORM OF DIFFERENT SPECIES. Yuan-lin Chen, Lan Liao, Mu-yan Gui, feng Zhou (The Cytobiology Research Department of the Xiamen University, Xiamen 361005, China), Zhi-yi Chen, Zhi-huan Luo, tian-xi Liu, Han-ying Chen (Sericultural Research Institute, Guangdong Academy of Agricultural Sciences).

DNA-protein extracted from eri silkworm (Philosamia cynthia ricini) was injected into moths of silkworm (Bombyx mori). Variations in the progenies of the DNA-recipients, and then six new strains of B. mori had been bred from the variated progenies. The property and mechanism of the DNA-induced variation and the prospect of applying this means in breeding were discussed.

IMPROVEMENT OF SILKWORM RACES IN CHINA. Yu-cheng Wu (Zhejiang Agricultural University, Hangzhou 310029, China)

Four race renovations of silkworm, Bombyx mori, during 40 years in China were reviewed. In Yantze river region, cocoon shell, percentage of spring rearing races is about 25%, length of cocoon filament more than 1400 meters, reelability about 75%, neatness higher than 93 marks. Health and quality of cocoon filament of summer and autumn rearing races have been greatly improved. Bivoltine races which spin white cocoon is used in every season in Zhujiang region. The author summed up the experience of breeding techniques in aspects of research of germplasma resource, breeding of commercial races, basic races, autosexing races, and healthy races. Furthermore, it was also presented the progress in the studies of quantitative inheritance, sex-control, mutation breeding, disease-resistance breeding, heterosis, cytogenetics and distant hybrid of silkworm. It is suggested that strengthening the collection, conservation and evaluation of silkworm germplasma resources, and exploring stocks possessed heriditary characteristics were very important in the work of silkworm. breeding in future ten years. In addition to developing evenly all over the characters of commercial races, moreover, it is also important to develop races with distinguishing qualities in the size of cocoon filament, the fluoride-resistance and the egg production, to pay attention to stock preservation, line breeding and regeneration of newly breeded races, and to prevent race degeneration.

THE PRACTICE AND THEORY OF RESISTANCE TO DISEASES BREEDING IN SILKWORN (BOMBYX MORI). Wen-Zhong Yi, Zhi-Fang Zhang (The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang, Jiangsu 212018, China)

In this paper discussed Character of resistance to diseases of silkworm, according to practices of resistance to diseases breeding of silkworm and the selection theory of threshold character, comparision and discussion suitable affection amount of pathogen and selection efficiency of different selection methods. Futher, we summarized separately new development of census, genetic law, correlation breeding, etc. aspects of resistance to CPV, SPV, DNV, Fluoride, Thuricide in silkworm.

We think that relation between nonsusceptible genes of silkworm to DNV and pathogenetic genes of DNV conform with the gene for gene hypothesis. According to this hypothesis densonuclesis epidemic and popularization of silkworm varieties, it was possible that DNV-I type appearance was earlier than DNV-II type. According to analysis of genetic law and selection data of resistance to Cytopolyhedrosis, it indicated that overdominance play an important role in maintaining genetic homeostasis between host-pathogen and polymorphism of host population. In a word, we regard the silkworm as a useful material for studying genetic relation between host and pathogen.

BREEDING OF BIVOLTINE STRAIN OF SILKWORM FOR MILD CLIMATE AND INDUSTRIAL REARING. Le Thi Kim, Dao Hong Canh (Central Sericultural Research Centre, Gia Lam, Ha noi, Viet nam)

Two silkworm strains were prepared from the Germ-plasm Bank of Research Centre. Thirty egg layings of each strain were reared separately. Inbreeding was executed from the first to sixth generation. Two pure-lines of each strain that have better hybrid performance were selected for crosses. The new strains were designed as 907 and 908. Combinations of two selected purebred-lines show hybrid superiority. It is possible to make pupal mortality decrease by 3.6 - 5%, survival increase by 13 -20%, cocoon yield increase by 42 - 44%, filement length increase by 200 metres as compared to the control. Quality of newly evolved strains and their F1 hybrid combination reached international grade 2A, 3A.

STUDIES ON GENETIC PARAMETER FOR SELECTING OF BI-MULTIVOLTINE SILKWORM STRAINS. Chanchai Tarvorn-anukulkit (Department of Entomology, Khon Kaen University, Khon Kaen, Thailand), Somsri Kantaratanakul (Department of Entomology, Kasetsart University, Bangkok, Thailand)

With a purpose of selecting a new silkworm strain with high response to selection, this experiment was carried out to analyze genetic parameters of the cocoon characters from a bi-multivoltine silkworm strain. It is apparent that characters with high heritabilities are important in selection programs because the response to selection will be high. Two populations of generation 6 hybrid derived from two parental strains, Indian origin namely, Bivoltine pink cocoon x Mysore (multivoltine), from which 4 lines were established from each group. They are characterized by cocoon color; white, greenish yellow, pinkish yellow and yellow. The full-sib analysis in nested design was evaluated with 5 replications. The results showed that high heritability (>0.5) of cocoon weight and shell weight in both male and female were found in the yellow cocoon lines in both populations. In addition, a pinkish yellow line in the second population exhibited the same. Therefore, it can be concluded that these two new bi-multivoltine lines could be used as initial breeding stocks to evolve superior varieties in a later stage of the breeding program. Low heritability, found in the greenish yellow cocoon line, indicated that it is not suitable as a breeding material. As male white cocoon line, high heritability was detected except in the male cocoon weight of the first population.

STUDIES ON DISTRIBUTION LAW AND CORRELATION ANALYSIS OF TWENTY ECONOMIC CHARACTERS IN SILKWORM STOCKS. Zhi-fang Zhang, Wen-zhong Yi (Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang, Jiangsu 212018, China)

It was quoted the data that was investigated in the spring 1981 in order to writing "The Silkworm Variety Catalogy in China". The database of variety resource was programmed in Foxbase. It included 332 varieties each of which has 32 item characters. The following Characters were analysed in this paper: fifth instar, larval stage, survival rate of larva, rate of died pupa, survival rate after both larva and pupa, cocoon weight, cocoon-shell weight, cocoon-shell percentage, filament, size, neatness, reelability percentage, length of non-broken cocoon filament, lousiness, weight of cocoon filament, boiling-off ratio, amount of cocoon filament/fifth instar, egg numbers, fine egg percentage and hatchability etc. The distribution law and characteristics of all the geographic groups of every character were discussed. The main results are as follows: survival rate, reelability percentage neetness, boiling-off ration, fine egg percentage and hatchability obey the poisson distribution, the others obey the normal distribution. The correlation and path analysis were also carried out, it showed that the correlation between reelability percentage and filament or weight of cocoon or weight of cocoon filament etc in the European group is insignificant, the correlation between survival rate and cocoon weight or cocoon-shell weight or cocoon-shell percentage etc in Chinese multivoltine is significant positive correlation. The results of path analysis indicated that pursuing one-sidelly high cocoon-sheel percentage in breeding will result in a change for the worse reelability percentage and less weight of cocoon filament.

STUDIES ON SELECTIVE EFFECT OF SOME PRACTICAL CHARACTERS OF SILKWORM BOMBYX MORI, Jialong Duan(Department of Sericulture, Anhui Agricultural College)

Several strains were used to study the selective effects of resistance to CPV and cocoon characters. As a result of 7-8 generation selection with CPV oral infection, the sound pupa ratio of the strain, Dong34, was 4.2-38.7% higher than that in the control, but, DaZao only increased 1.7-1.8%. Both the sound pupa ratio and the cocoon quality in the interval-gene--ration selection with CPV were superior to those in the suc--cessive-generation resistant selection with CPV. The concen--trations of CPV used in Spring and Autumn could be 10^5, $\frac{1}{2}X10^5$, $\frac{1}{4}X10^5$ and 10^4, 10^3, 10^2 respectively. The general performance of cocoons from the resistant selective blocks which were selec--ted for reprodution was almost the same to that from the con--trol blocks. After five generations of mass selection the co--coon weight, cocoon shell weight, cocoon shell ration and laying of each female were increased by 2-3%, 5-33%, 1-8% and 15-32%, depending on differant strains and characters.

COCOON CHARACTERS OF HYBRID BETWEEN WILD AND DOMESTIC SILKWORMS, (*Bombyx mandarina* and *B. mori*). T. Nakada (Faculty of Agriculture, Hokkaido University, Sapporo 060, Japan)

Progeny tests after crossing between wild and domesticated silkworms were carried out, and the sequenece of change in some cocoon characters was statistically analysed. Cocoon weight of wild silkworms collected in their natural environment was considerably lighter than that of domesticated ones tested. Their shapes were not uniform, but were expressed diversely from elliptic to spindle type. In contrast the domesticated strain adopted for hybridization and repeated backcrossing experiments has shown a stable peanut shell type.

Cocoon weight of hybrids increased linearly with proceeding generations of backcrossing, and the weight reached the level of the domesticated strain very early.

Cocoon shape changed gradually from a wild type to a domesticated one during the procedure of experiments. The process of genetic exchange was statistically analysed through the technique of multivariate analyses using combined variables of some cocoon characters.

STUDIES ON THE COMBINING ABILITY AND HETEROSIS OF THE NEW MULTIBI HYBRIDS.

G. SUBRAMANYA AND G. SREERAMA REDDY

Sericulture Section, Department of Studies in Zoology, University of Mysore, Manasa Gangotri, MYSORE-570 006. INDIA.

The General and Specific Combining Abilities of the new Bivoltine races MU_{281} and MU_{287} with the multivoltine Pure Mysore race as lines were estimated by rearing the F_1 hybrids both under laboratory and field conditions. Heterosis was calculated in F_1 hybrids by analysing the quantitative traits such as fecundity, larval duration, yield by number and weight, cocoon weight, shell weight, shell ratio and filament length in comparison with the parents. The F_1 hybrids were observed to be superior over the parents for most of the traits analysed indicating heterosis. The advantages of new multi-bi hybrids over the traditional ones are discussed.

EFFECTS OF CONTINUOUS DIRECTIVE BREEDING AND SELECTION ON RAISING COCOON SHELL RATE IN SILKWORM (BOMBYX MORI L.). Jingyu Cheng, Yugong Luo, Wanchen Li, Xisan Fu (Shaanxi Sericultural Research Institute, China)

In the study, the methods of directive breeding and selection have been used to raise the cocoon shell rate of cross materials from about 27 to 30 percent or more and create three basic Chinese races through continuous selection of 32 generations, the cocoon shell rate of which is the highest in the world. This paper had introduced the concrete methods of breeding and selection and discussed some theoretical problems concerned.

THE BREEDING OF BASIC SILKWORM RACE EH1 XIN WITH HIGH COCOON SHELL WEIGHT. Zhang Min-yi, Ye Xia-yu, Cao You-feng , Zhao Qiao-ling(The sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang 212018, China)

Silkworm race is the foundation of sericulture. Popularizing the good silkworm races is the effective means of improving the economic benefit of silkworm rearing. The original materials currently used for breeding new silkworm races often have close blood relation and similar characters, as well as relatively good economic characters. So it is necessary to breed some basic races which have some genetic differences. The successfully bred basic silkworm races EH1 XIN with high cocoon weight has the characteristic of high cocoon shell weight (0.7g) normal larval duration (23--24 days), high silk/leaf ratio and coarse silk size(3.8--3.9D). It can be used as the material for breeding new races with high silk weight and coarse silk size.

RECENT ADVANCES OF NUTRITIONAL PHYSIOLOGY AND ARTIFICIAL DIET OF BOMBYX MORI IN JAPAN. Y. Horie(Institute of Silkworm Genetics and Breeding, Ami, Inashiki, Ibaraki, 300-03, JAPAN)

Significant advances in the research on silkworm nutrition began with the development of artificial diet. The qualitative and quantitative requirements of various kinds of nutrients essential for growth and survival of the silkworm have been established. The gross amounts of dry matter, energy, carbon, nitrogen and other nutrients ingested and metabolized by a single larva throughout its life cycle were measured. The biochemical functions and deficiency effects of nutrients in silkworm metabolism have also been investigated.

The accumulated information on silkworm nutrition resulted in a considerable improvement of diet composition. Thus, the rearing technique on artificial diet has been introduced in the practical use in the form of cooperative rearing of young silkworms. This extended technique is very useful for the labor saving management in sericulture together with applying an automatics rearing machine.

Furthermore, in order to reduce the diet-cost, the design of the diet composition was carried out by a linear programming method by application of the ingredients for both domesticated animals and fowls. Because of unpalatability of designed low-cost diet for silkworm, the new strain of silkworm was breeded successfully, and this strain has the novel character with wide-feeding response like polyphagous. This strain was easily reared on the low-cost diet. This technique might be of great benefit to sericulture in the near future.

NUTRITIVE EFFECTS OF ASPARAGINE AND GLUTAMINE ON THE SILKWORM, *Bombyx mori*. Toshio Ito (Kanto Junior College, Ohya-cho, Tatebayashi, Gunma 374, Japan) and Tamio Inokuchi (National Institute of Agro-biological Resources, Tsukuba, Ibaraki 305, Japan)

The domesticated silkworm requires either aspartic or glutamic acid in addition to the usual ten essential amino acids and semi-essential proline for a normal growth (Ito, 1972). In addition, dietary aspartic acid could be replaced by asparagine, while glutamic acid was replaced partly by glutamine, when younger larvae were tested (Arai and Ito, 1977). Further data on the nutritive effects of two amides will be shown here. Nutritive effects were investigated by growth experiment using defined diets as well as by the analysis of free amino acid composition of the hemolymph of larvae reared on the varying diets.

Growth experiment with half-grown larvae confirmed the previous result that asparagine was effective, while the effect of glutamine was not clear-cut.

When the defined diet lacked both aspartic and glutamic acids, free amino acid composition of larval hemolymph underwent a marked change. Three amino acids (glutamine, alanine, and lysine, in this order) were decreased markedly, while six amino acids (histidine, isoleucine, leucine, methionine, ornithine, and valine) increased noticeably. The rates of increase and of decrease in those amino acids were accelerated after further deletion of the non-essential amino acids and proline from the diet of which two acidic amino acids had been deprived.

The normal amino acid pattern was resumed by including either aspartic or glutamic acid or both into the deficient diet. Furthermore, the inclusion of either asparagine or glutamine was also proved to be effective, more or less, for the recovery of the normal amino acid pattern. Analysis of free amino acid pattern is considered to be useful for the estimation of the nutritional value of amino acids and related compounds.

RESEARCH ON IMPROVEMENT OF EFFICIENCY OF TRANSFORMING LEAF INGESTED INTO SILK OF THE SILKWORM, BOMBYX MORI. Jun-liang Xu, Xiao-feng Wu(Zhejiang Agricultural University, Hangzhou 310029, China)

Efficiency of transforming leaf ingested into silk of the silkworm, Bombyx mori, is an very important economic index of cocoon production. In this paper, the influence of different kinds of factor on the efficiency of tranforming leaf ingested into silk was discussed based on genetic-physiology, nutrient-physiology and rearing techniques of the silkworm, etc. Moreover, the way to improve the efficiency of transforming leaf ingested into silk was proposed as follow: 1. breeding the races of mulberry and silkworm which present a high efficiency of transforming leaf ingested into silk. 2. providing a suitable environment for the silkworm and strengthening the management of rearing with economic feeding. 3. feeding male larvae. 4. applying some physiological active agent and nutrient which could improve the efficiency of transforming leaf ingested into silk. 5. increasing the digestibility of the silkworm with biological techniques.

BRAIN cAMP LEVELS AND THE INDUCTION OF DIAPAUSE IN THE OAK SILKWORM, Antheraea pernyi G. Ming-xian Lu, Yi-chen Zhang, Qi-mao Xu, Ren-dong Zhao, An-chang Hu, De-xu Shun (Shenyang Agricultural university, Shenyang 110161, China)

cAMP contents in the brains of the fifth instar larvae, pharate pupae and pupae of A. pernyi were determined using radioimmunoassay. The spring generation differed greatly from autumn generation in their cAMP contents in the brains. cAMP level was significantly low during the feeding period of fifth instar larvae of the spring generation as compared with the autumn larvae destined to undergo pupal diapause. cAMP peaked at the pharate pupal stage in both generations, with much higher level occurring in the autumn pharate pupae than in the spring ones. A sustained low level over early autumn pupal period following a dramatic decline in cAMP level on day 1 of young pupae suggests that the induction of pupal diapause is attributed to low cAMP level in the brain.

THE EFFECT OF VARIOUS LEVELS OF DIETARY PROTEIN FED ON FIRST INSTAR ON VIABILITY, GROWTH AND DEVELOPMENT OF BOMBYX MORI L. SILKWORMS. Elisaveta Genova, Nikolai Todorov(Institute of Zootechnics and Veterinary medicine, Stara Zagora-6000, Bulgaria).

Silkworm larvae of Super1xHesa2, Hesa2xSuper1 and Shunreix Shogetzu, were reared on diets at various levels of dietary protein(18,22,26,29%)during 1st instar. The artificial diets contained 35%mulberry leaf powder, 5%cellulose powder, 6%succrose, 7,5% agar, 3%Wesson mix, 1,5%soybean oil refined, 1,5%ascorbic acid, 3,5%citric acid, from 16-37%soybean meal in relation to the required protein level. With low protein mixtures the soybean meal is replaced for by potato starch, energy adjusted at a relatively constant value(isoenergetic mixtures). Second star and following larvae were fed on spring mulberry leaves by the routine methods. Survival of larvae fed on mixtures of different protein content was similar with all ages, althouth a tendency towards some shortening of the 1st instar larvae survival fed on 18%protein diet, was observed. The tendency kept on during the following ages. The period of larval development was not influenced significantly by the protein level. The body mass of larvae at the end of the 1st age is significantly lower with all hybrids fed on 18% protein diets compared to the 26 and 29% protein diets. Retardation(1st instar) was made up for by a faster growth during the following ages, the 4th and 5th instar larvae being of a similar weight.

The experimental data put to the suggestion that the 1st instar larvae protein requirements were in the ranges of 26-29%.

The protein level was of a significant effect on the weight gain unlike other dietary indeces.

HORMONAL REGULATION OF PHEROMONE BIOSYNTHESIS IN THE SILKWORM MOTH, BOMBYX MORI. R. Arima, A. Suzuki (Department of Agricultural Chemistry, The University of Tokyo, Bunkyo-ku, Tokyo 113, Japan), T. Ando (Depertment of Applied Biological Science, Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183, Japan)

One probable biosynthetic pathway for the sex pheromone of B. mori females [bombykol, (10E,12Z)-10,12-hexadecadien-1-ol] is as follows; acetyl CoA --> hexadecanoate --> (Z)-11-hexadecenoate --> (10E,12Z)-10,12-hexadecadienoate --> bombykol. This pheromone production is controlled by a hormone, termed pheromone biosynthesis activating neuropeptide (PBAN). In order to understand the mode of action of PBAN, the incorporation of ^{14}C from ^{14}C-hexadecanoic acid and ^{14}C-hexadecadienoic acid into bombykol and the biosynthetic precursors was examined by some in vivo and in vitro experiments with or without PBAN. The results suggest that the PBAN mainly regulates the reduction step of an acyl moiety in the biosynthetic pathway rather than desaturation steps.

A STUDY ON THE ALKALINE PHOSPHATASE IN THE MIDGUT OF THE SILKWORM, BOMBYX MORI L. Yungen Miao (Department of sericulture, Zhejiang Agricultural University. Hangzhou 310029, China)

The activity of the alkaline phosphatase (ALKP) was low during the larval moulting stage and increased gradually after moulting. The highest activity appeared before the gluttonous stage of the fifth instar, after that it decreased and the lowest enzyme activity was showed in the mature larval stage.

The effect of CPV and NPV on the ALKP of the midgut was different. There was a marked drop in the ALKP of the midgut when larvae were infected with CPV, but not with NPV. This suggested that the pathogenic mechanism of CPV should be different from that of NPV.

Bacillus thuringiensis damaged the midgut tissue of silkworm directly. and therefore it caused the ALKP activity to be declined rapidly.

In the case of fluoride administration, the ALKP activity of the midgut decreased from the second day after treatment. This result suggested that the activity of digestion and absorption of the midgut tissue decreased as fluoride damaged the larva of the silkworm.

Among various chemicals, the activation of Mg^{++} on the ALKP of the midgut was most evident. Vitamine C, Ca^{++}, citric acid and Cl^{-} could inhibit the ALKP in vitro.

THE INFLUENCE OF HIGH TEMPERATURE ON THE GROWTH AND DEVELOPMENT OF MALE ACCESSORY GLANDS AND THEIR SECRETIONS IN SILKWORM (Bombyx mori L.)Yongwen Ouyang and Weiguang wu(South China Agriculture University)

1. At high temperature, the male accessory glands showed abnormal shapes, shorter length (shortened by 20.95-40.76%) and lighter dry weight (reduced by 30.32-40.76%).
2. High temperature caused changes in the histological structure and ultrastructure, such as thinning of the cell layer, non-homogneous nucleoplasm,damaged nuclear system, broken rough endoplasmic reticulum, ribosomes detached from rough ER to form polyribosomes, damaged mitochondria, appearance of lysosomes.
3. The protein and amino acid contents decreased, the percentage reduction of protein being 23.72-65.82, and the mole percentage of amino acid changed. Polyacrylamide gel electrophoresis revealed difference between the protein bands from silkworm reared under high temperature and those reared under normal temperature.
4. The DNA and RNA content showed a decrease of 9.54-20.55% and 35.04-39.56% respectively.
5. The activity and number of motile sperms varied with the duration of the high temperature treatment, the longer the time, the weaker the activity and lesser the number.

OVIPOSITION BEHAVIOUR IN SILKWORM MOTHS, *BOMBYX MORI*. L (LEPIDOPTERA: BOMBYCIDAE) UNDER TROPICAL CONDITIONS. A. Manjula (Karnataka State Sericulture Development Institute, Thalaghattapura, Bangalore-560 062, India)

The oviposition pattern in the popular multivoltine (Pure Mysore), bivoltine races (NB7, NB18, KA and NB4D2) and their related hybrid silkworm races has been investigated. The female moths after depairing were allowed to oviposite at different temperatures of 24°, 27°, 30° and 35°C for three days. The number of eggs oviposited was recorded for every two hours once, to calculate the zero hour of oviposition. The results are discussed based on the effect of environmental factors on the oviposition pattern in silkmoths for calculating the zero hour for tropical conditions.

EFFECT OF RE-REFRIGERATION ON HATCHING OF NON-DIAPAUSE EGGS OF SILKWORM, BOMBYX MORI.L. G.V.Reddy & Chandrasekharaiah (SSTL, Kodathi, carmelram, Bangalore-35, India), C.J.Prabhakar (CSR&TI, Mysore-

Re-refrigeration of non-diapause eggs for 5-30 days was conducted after the break (at 25°C) of refrigeration for varied durations of 12h, 24h, 36h and 48h to see the cold tolerance with reference to hatchability. The eggs of 12h, 24h and 36h aged were preserved at 5°C with 75-80% R.H. for 5-40 days. The break to the refrigeration was given after 10 days of preservation of eggs. Later the re-refrigeration of eggs was continued for 30 days. After every 5days of refrigeration and re-refrigeration, the eggs were leased for incubation.

The cold effect on multivoltine race, Pure Mysore eggs resulted in drastic reduction in hatching both in 12h and 36h aged eggs, while in 24h eggs the hatching was normal upto 30days of refrigeration. 12h break of refrigeration increased, the hatching significantly high throughout the 30days of re-refrigeration in 12h eggs whereas, 48h break was effective in getting good hatching upto 10days only. The combining effects of re-refrigeration and duration of break on hatchability have been discussed.

EFFECT OF DENSITY AND SPACE ON THE GROWTH OF SILKWORM REARED WITH ARTIFICIAL DIET OFFERED ONCE DURING 1ST TO 3RD INSTAR. Chuan-xi Zhang (Section of Entomology, Zhejiang Agricultural University, Hangzhou,310029,China;Ruiying Chen,Hajime Mori, Motoyuki Sumida Fujiyoshi Matsubara(Dept. Applied Biolology, Kyoto Institute of Technology, Kyoto, 606, Japan)

The aseptic rearing method for the silkworm, Bombyx mori, with artificial diets to be offered at one time for the whole period from the 1st instar to the end of 3rd instar may save energe and work, and reduce disease infection. The relationship between rearing density, space and synchronization of growth and growth rate of silkworm was studied in this paper. The growth rate and body weight were decreased as the rearing density increased from 10 to 210 heads in a plastic case of 320 cm^2. The space height rangining from 1.0 to 6.0 cm above the diet showed little effect on the growth and average weight of silkworm 11 days after hatching. It was disclosed that in the commercial base cocoon production, the rearing density of silkworm appropriate for the aseptic rearing method with artificial diets to be offered at one time for the whole period from hatching until the end of 3rd instar was 2.2-2.5 cm^2 per larva.

GEO-ORIENTATION AND PHOTO-ORIENTATION BEHAVIOR OF BOMBYX MORI AT TERMINATION OF COCOON CONSTRUCTION Isamu Shimizu, Seiji Hori (Center for Ecological Research, Kyoto University, Kitashirakawa Kyoto 606, Japan)

Silkworm larvae showed both negative geo-orientation and positive photo-orientation at the termination of their cocoon constructions. Only a few moths were able to escape from the cocoons if the prepupae assuming ordinary head-up posture were inverted in the cocoons. The gravitational response was predominant when a light was present near the lower end of vertically-set cocoons. Illumination at the upper end increased the frequency of larvae assuming the final head-up posture in cocoons when the long-axes formed angles between 0-15 degrees from horizontal. The threshold value evoking the photo-orientation response was between 2-20 lux. Vitamin A-deficeint and white-eye larvae of ommochrome-deficient mutant failed to show the photo-orientation. Experiments in which larvae were coated with paint revealed that one particular posterior ocellus located on both sides functions to receive light in the photo-response. The functional significance of the orientation behaviors in the silkworm is discussed.

THE PRESENT STATUE AND THE DEVELOPMENT OF TROPICAL AND SUBTROPICAL SERICULTURE Weiguang Wu (Regional Sericulture Training Center for Asia & the Pacific, South China Agricultural University), Shixian Liu (Sericultural Research Institute of Guangdong Academy of Agricultural Sciences)

There are approximately 30 countries in the tropical and subtropical zone which are engaged in sericultural production and their silk production is nearly 1/4 of the world's total. Sericulture in the zone has a great potential due to the long growing-period of the mulberry tree and the abundance of land and labor. However, there also exist problems like excessively high temperature which causes difficulties in rearing and egg production, and favours the occurrence of pathogens and pests. The authors pointed out measures to be adopted in order to promote sericulture in the zone , namely: 1.Establisment of fast-growing, densely-planted , high-yielding mulberry gardens in order to provide a maximum amount of leaves; 2. Breeding of high-temperature-resistant, desease-resistant, superior quality silkworm races; 3. Emphasis on disinfection and disease prevention; 4. Selection of suitable areas and proper techniques.

STUDIES ON THE EFFECT OF CLIMATIC FACTOR ON COCOON PRODUCTIVITY IN PURE MYSORE RACE OF *BOMBYX MORI*.
R. Gururaj and P. Somasundaram (Regional Sericultural Research Station, Salem-636 003, India)

Sericulture is thriving in Southern India because of its indigenous Pure Mysore a multivoltine race being exploited as ubiquitous female parent for commercial silk production. A survey in Denkanikottai which lies on the tip of Deccan plateau at an altitude of 3000 ft MSL; which has been demarcated as local multivoltine seed area characterized by the maximum temperature deviation ranging from 20 to 30°C; minimum temperature ranges from 15 to 26°C and humidity varies from 62% to 86%. However in winter season, maximum and minimum temperature fluctuates between 20°C to 27°C and 15 to 16°C respectively, which were found to be optimum, contributed for enhancing yield by upto level of 7719 Nos per unit of 10000 larvae, resulting in higher seed cocoon production. A multiple correlation of all these factors revealed that maximum temperature from 20 to 22°C and minimum temperature of 15 to 16°C has its direct impact on cocoon production which is significant at $P < 0.05$. However, relative humidity has no direct impact on cocoon production in seasons except during summer months. The rainfall which received from April to November has no direct impact on cocoon production. Irrespective of season, Pure Mysore is a very consistant race for giving constant production.

SILKWORM REARING AND SUSTAINABLE ECO-AGROSYSTEM IN CHINA. Shen Xing-jia, Li Yi-ren(The Sericultural Research Institute, Chinese Academy Of Agricultural Sciences, Zhenjiang 212018, China)

Sericulture originated in China has been producing a far-reaching influence to agriculture even indutry. The paper introduces and analyses three main forms: 1. silkworm rearing and rice producing; 2. mulberry land--fish pond eco-system; 3. shelter belt and silkworm rearing. In these systems mulberries、silkworms、rice、livestock、fish and their environments are closely tied as a whole. Therefore utilization ratio of materials、energy、land are much higher than other managements. Moreover, great effects have been made by these systems in conservation of forests、water and soil, soil improvement, environment protection and ecology balance. To improving the eco-agrosystem it is necessary to properly programm sericulture regions、stereotypedly develope mulberry land and effectively utilize sericultural by-products. Meanwhile the influence to silkworm caused by changes of eco-environment and its solution must be studied as well.

NEW APPROACHES IN TROPICAL SERICULTURE
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Karnataka State Sericulture Development Institute
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In tropics, silkworms are reared continuously throughout the year resulting in increased pathogen load in the environment. Complete removal of pathogens becomes difficult, as most of the farmers rear the silkworms in their dwelling houses which results in crop loss or poor quality. Further, the cost of cocoon production is also affecting due to continuous increase in the input cost and poor yield. With a view to stabilize the crop and to cut-down the input cost, K.S.S.D.I. took up studies on modifying the existing technology to suit the different socio-economic class of farmers. The major components include - (a) Split crop method of rearing to minimise the initial investment and maximise the utilization of infrastructures; (b) Use of Isolation Chamber for young silkworm rearing for crop stability and quality; and (c) Shoot rearing method in tropics for late age worms to minimise labour requirement. The above components have been tried in large scale and found effective in stabilizing the crop, improving the cocoon yield and quality and also in reducing the cost of cocoon production.

XVIS-4 Hormones Regulating Metamorphosis and Diapause in Silkworms and their Application to Sericulture

CHANGES IN HAEMOLYMPH ECDYSTEROID AND JH TITRES UNDERLYING LARVAL-PUPAL METAMORPHOSIS IN BOMBYX MORI.
Sho Sakurai (Department of Biology, Kanazawa University, Kanazawa 920, Japan)

JH titre was determined every 12 h through the fifth larval stadium by JH-RIA using anti-JH-I antiserum. JH titre was considerably high immediately after the fourth larval ecdysis. It declined to low level 12 h after ecdysis and remained at very low levels from day 2 through the day of head critical period. Then it initiated to increase again and gradually increased until the pupation. When haemolymph ecdysteroid contents were determined every 2 h from the fourth larval ecdysis through pupation, three distinguishable peaks at least have been observed in the second half of the feeding period. First small peak (1-2ng/ml) was observed on the day when brain removal did not prevent further development. Second (10ng/ml) and third one (15-20 ng/ml) appeared to correspond to spinneret pigmentation and gut purge, respectively. Correlation between the small increases in ecdysteroid titre and three developmental events, i.e. spinneret pigmentation, initiation of spinning and gut purge, was examined by injecting various doses of 20-hydroxyecdysone one or two days before the onset of spinneret pigmentation. Results indicate that developmental events occurring sequentially are induced by gradual increase in haemolymph ecdysteroid titre but each event are independent from the other.

THE PRODUCTION OF SUPERFINE COCOON FILAMENTS BY INSECT GROWTH REGULATORS. Xue-fang Lu (Zhejiang Agricultural University, Hangzhou 310029, China)

In 1985, we firstly succeeded in inducing trimoulter with chemicals (SM-1) to produce superfine cocoon filament. Afterwards, new trimoulter inducers (Golden Deer) were developed. When the silkworms are feeded with a proper concerntration of chemicals for a certain time at 3nd or 4th instar, all the silkworms will become trimoulter.

The induction of trimoulter of commercial races can be carried out during every season, and the cocoon filament size can be regulated between 1d and 2d which is 1/3-1/2 finer than that of the tetramoulter. The induced trimoulter shows stronger resistance and has a smaller percentage of disease. The reelability percentage of the induced trimoulter cocoon is remarkably higher than that of the control. The inducing technique for trimoulter has been released and applied in Jiangsu and other provinces during the past six years.

The quality of these kinds of superfine cocoon filaments is excellent. Characteristics such as less size deviation, better evenness, neatness, higher tenacity, elongation, cohesion and other advantages are found. The raw silk reeled in great deal reached 4A to 5A. About 80 tons of fine raw silk (13/15) and about 10 tons of fine silk composite yarn were produced. Many light fabrics such as chiffon and habotai etc. were also woven.

THE MECHANISM OF ACTION OF ANTI-JUVENILE HORMONE SM-1 ON THE INDUCTION OF PRECOCIOUS METAMORPHOSIS OF THE SILKWORM.
Zhong-yuan Shen(The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang 212018, China)

Administration of 50-80 μg/larva of SM-1 to the 3rd instar or 4th instar larvae, precocious metamorphosis of the silkworm was induced and all the treated larvae became trimolter, which could be counteracted with application of juvenile hormone analogue or moulting hormone simultaneously or sequentially. SM-1 also inhibited the increase of volume of cropus allatum and stimulated the DNA and RNA synthesis in the posterior silkglands in silkworm. Combination with all results obtained in this experiment, the author considered that SM-1 depressed the secretion of juvenile hormone and moulting hormone and a new homeostasis of hormones formed which advance the promotion and expression of genes responsible for the silk protein synthesis and development and metamorphosis of the silkworm. Thus, precocious metamorphosis of the larvae was induced.

STUDIES ON THE ACTION MECHANISM OF AN IMIDAZOLE COMPOUND KK-42--INHIBITORY EFFECTS OF KK-42 ON THE JUVENILE HORMONE SYNTHESIS IN CORPORA ALLATA OF SILKWORM, BOMBYX MORI. Jin-mei Wu (The Sericultural Research Institute, Chinese Academy Of Agricultural Sciences, Zhenjiang 212018, China)

In order to study the mechanism of action of the imidazole compound KK-42 which acts as an inducer of the trimolter silkworm, the synthesis of juvenile hormone(JH)by isolated silkworm corpora allata(CA)was determined in vitor by means of a short-term radiochemical assay. The ecdisone titers in the haemolymph were determined according to the method of radioimmunassay. Combining the culture of the prothoracic glands(PG)and brains with the radioimmunoassay of ecdysone(MH), the secretory kinetics of PTTM in the brains after treatment with KK-42 was determined successfully. Together with other experiments, a new theory about the mechanism of KK-42 action is proposed.

The result of the study indicated that the target organ of KK-42 was CA. When KK-42 was applied in the early stage of the fourth instar, the synthetic activity of CA was decreased. Accordingly, it fedback to the brain so that the PTTM secretion was also decreased. THe latter action delayed the increase of MH titer in the haemolymph. It was the co-action of this delayed MH peak and relatively lower JH titer that induced the precocious pupation and the trimoltism of the silkworm.

EFFECT OF REMOVING SILKWORM LARVA SUBOESOPHAGEAL-GANGLION ON LIPID METABOLISM IN PUPAL STAGE. Dayang Wu, Jinting Wu (Southwest Agricultural University, Chongqing 630716, China)

The concentrations of lipid such as triacylglycerol and free fatty acids in the ovaries of silkworm pupae from the larvae removed suboesophagealganglion before pupation were relatively decreased as compared with those from normal larvae. Their contents in fat bodies and blood, however, were increased. These results indicated that the accumulation and transcolation of lipids amoung fat bodies, blood and ovaries were, in some extance, regulated by suboesophagealganglion.

EFFECTS OF IMIDAZOLE COMPOUND (KK-42) ON OVARIAN DEVELOPMENT AND PROTEIN BIOSYNTHESIS OF PUPA IN SILKWORM, BOMBYX MORI. Naiming Zhou (Zhejiang Agricultural University, Hangzhou 310029, China)

In order to make the acting mechanism of KK-42 and the mechanism of hormonal control on the ovarian development clear, imidazole compound (1-benzyl-5((E)-2,6, -dimethyl-1, 5-heptadienyl) imidazole, i.e. KK-42) was applied to the pupae and the freed pupal abdomen of the silkworm to investigate its effects on the ovarian development and the protein biosynthesis. The results revealed that the ovarian weight and the number of eggs laid was inhibited markedly by KK-42. The retardation of the ovarian development with the KK-42 treatment was clearly recovered by injection of -ecdysterone, but deteriorated by injection of juvenile hormone analogues. The protein bands of ovaries and hemolymph in pupae treated with KK-42 on gel electrophoresis had no difference compared with the control, but there was a slight change in the protein content of hemolymph and a little increase in the protein content of ovaries due to treatment of KK-42, while the protein content of hemolymph in the control increased rapidly after pupation and reached to peak on 3rd day, then declined rapidly and the increase of ovarian protein was identical with the decline of hemolymph protein. These suggested that not only protein biosynthesis in hemolymph but also transfer of protein from hemolymph to ovaries was inhibited by KK-42 treatment.

Hormones Regulating Metamorphosis and Diapause in Silkworms and their Application to Sericulture

XVIS-4

DIAPAUSE HORMONE OF THE SILKWORM, *BOMBYX MORI*: STRUCTURE AND FUNCTION. O. Yamashita, M. Ikeda, Y. Sato, M. Isobe (School of Agriculture, Nagoya Univ. Nagoya 464-01, Japan), K. Imai (Faculty of Bio-Resource, Mie Univ. Tue 514, Japan).

Diapause of silkworms occurs in the early stage of embryogenesis, which is induced by a neuropeptide, diapause hormone (DH). DH is secreted from the suboesophageal ganglion (SG) throughout pupal-adult development. DH is extracted from more than 50,000 SGs of pupae and purified to a single peptide through RP-HPLC. The isolated DH was sequenced to give the primary structure and the structure was confirmed by chemical synthesis of peptides as follow:

TDMKDESDRGAHSERGLCFGPRL-NH_2

Studies on structure-activity relationship revealed that the C-terminal region bares the active center of the hormone. This region showed higher homology in structure to the pheromone biosynthesis activation neuropeptide and the myotropic neuropeptides which are all secreted from SG.

The injection of the synthetic hormone can induce diapause eggs in many polyvoltine strains of silkworms, providing a new method for long term preservation of eggs of polyvoltine races. DH expressed its biological action on developing ovaries to stimulate trehalase activity through protein synthesis.

We have prepared cDNA and specific antiserum for DH, so that expression of the DH gene and the localization of DH peptide in relation to tissue and developmental stages will be discussed to address the question of how DH regulates the embryonic diapause of silkworms.

ECDYSTEROIDS IN BOMBYX EGGS

Haruyuki Sonobe, T.Masumoto, Y.Mamiya and M.Kamba (Department of Biology, Konan University, Higashinada-ku, Kobe 658, Japan)

There are two physiological types of eggs, the diapause type and the non-diapause type, in the silkworm, Bombyx mori. In the non-diapause type, embryos develop continuously, and larvae hatch 11 days after oviposition. Whereas, the diapause type is characterized mainly by a cessation of embryonic development at the stage of gastrulation and the onset of anaerobic carbohydrate metabolism.

The eggs of Bombyx silkworm have been found to contain high titers of ecdysteroids before the embryonic prothoracic glands have differentiated. However, the biological role of the ecdysteroids is still not clear. In order to elucidate this point, we studied developmental changes of the ecdysteroids in the diapause eggs and the non-diapause eggs, using RIA and HPLC. Nine free ecdysteroids and their phosphoric ester (conjugated form) were detected throughout early embryogenesis. These ecdysteroids drastically fluctuated during embryogenesis. We will discuss the function of the ecdysteroids in relation to physiological changes in the diapause eggs and the non-diapause eggs.

HORMONAL FACTORS RELATED TO DIAPAUSE OF PHARATE FIRST INSTAR LARVAE IN THE WILD SILKMOTH, *ANTHERAEA YAMAMAI*.

K. Suzuki, S. Naya, T. Kumagai, A. Seino, A. Sagisaka (Faculty of Agriculture, Iwate University, Morioka, Japan) and E. Kuwano (Department of Agricultural Chemistry, Kyushu University, Fukuoka, Japan)

We have supposed that a repressive factor (RF) originated in the mesothorax inhibits the secretion or synthesis of a maturation factor (MF) in the region of the 2nd to 5th abdomens during diapause in pharate first-instar larvae in the wild silkmoth. When this diapause is broken by chilling or imidazole derivative (KK-42) application, MF is delivered from RF and functions for the development of post-diapause. These assumptive and humoral factors have been investigated. Assay elutes from C18-column of haemolymph extracts of diapausing and diapause-terminated individuals had each activity such as RF and MF. Thus we can introduce the possibility of new endocrine system controlling diapause of pharate first-instar larvae.

CHEMICAL CONSTITUTION AND PHYSICOCHEMICAL PROPERTIES OF THE FIBROIN IN SILKGLAND, COCOON SHELL AND RAW SILK PRODUCED BY CHINESE SILKWORM STRAING. Guo-Di Qian (Suzhou Institute of silk textile Technology, Suzhou 215005, China)

This paper summarized recent research results about the chemical constitution and physicochemcat-properties of the fibroin in silkgland, cocoon shell and raw silk produced by Chinese silkworm straing. The results revealed that the physicochemical properities(isoelectric points, molecular weights, dissolubillity, adsorptivity, thermal stability, light oxidation resistance, and mechanical properties etc.) have close relationship with chemical constitution and structure of silk fibre. If some constitution and structure of silk will be changed by means of the gene engineering and chemical modification, then fibre property have a certain extent improvement. This offer some refrence for biological synthesis, sericultural production, raw silk processing.

THE PRIMARY STRUCTURE AND ORGANIZATION OF SILK FIBROIN GENE. K. Mita, S. Ichimura (Div. of Biology, Nat'l. Inst. of Radiol. Sci., Anagawa, Chiba 260, Japan)

We have sequenced a number of cDNAs representing the amino and carboxyl termini of Bombyx mori silk fibroin H-chain. The sequence analysis reveals that central core region is composed of alternative arrays of the crystalline "element a" [(Gly-Ala-Gly-Ala-Gly-Ser)$_n$] domain and the non-crystalline "element b" [(Gly-Ala-Gly-Ala-Gly-Ala-Gly-Tyr)$_n$] domain. The core region is partitioned by a homogeneous non-repetitive amorphous domain of around 100-base length that appears approximately every 1 - 2kb intervals. The unit sequence of element a is perfectly conserved throughout core region, while the element b shows often some variability in length of unit and the substitutions of Ala to Val. There is some heterogeneity in the repeat number of unit sequence in both elements. The repetitive super-structure of fibroin gene may have been a result of continuous unequal crossovers in a primordial gene during evolution.

The amino acid sequence of the amorphous domains is vastly different from that of the repetitive regions, notably for the presence of Asn, Asp, Glu, Lys, Phe, Pro, Thr and Trp residues. The carboxyl terminal non-repetitive region of B.mori fibroin H-chain has three Cys residues and nine Arg+Lys residues. These residues may be responsible for complex formation with the fibroin light chain molecules. The amino terminal non-repetitive domain sequence is very similar to that of signal peptides, which agrees with the fact that silk fibroin H-chain is a secretory protein. In addition, the extensive DNA sequence analysis presented here clearly demonstrates the 'tRNA adaptation phenomenon of the posterior silk gland.

ELUCIDATION OF SUBUNIT-BINDING SITES IN FIBROIN H- AND L-CHAINS AND THEIR DISRUPTION IN "NAKED PUPA" MUTANT SILKWORMS. Shigeki Mizuno (Dept. Agric. Chem., Tohoku University, Sendai 981, Japan)

Silk fibroin from Bombyx mori consists of a heavy (H)-chain (350 kDa) and a light(L)-chain (25 KDa) which are linked by a disulfide bond. The H-L combination is essential in efficient secretion of fibroin. Among three Cys residues in the L-chain, Cys-190 has been suggested to form the disulfide bond with the H-chain. Polyclonal antibodies against an L-chain peptide containing Cys-190 reacted with a FPLC fraction of the trypsin-digested unreduced fibroin. After reductive carboxymethylation, this fraction yielded two peptides ;8-3 and 8-10. Amino acid sequence of 8-10 corresponded to that of the L-chain peptide. DNA probes synthesized according to the amino acid sequence of 8-3 hybridized to a 3'-end HinfI fragment of the H-chain gene. Sequencing of this fragment revealed the presence of an 8-3-encoding region contining a Cys-codon. In Nd-s or Nd-s^d "naked pupa" mutant, secretion of fibroin is severely reduced and the H-L combination is not formed in the silk gland cell. Cloning and sequencing revealed that L-chains produced in these mutants did not contain sequences derived from the 4th and 5th exons (thus, no Cys-190) but contained a new C-terminal sequence derived from two exons that are present about 10-kb downstream of the normal L-chain gene.

REGULATION AND STRUCTURE OF AMINOACYL-TRNA SYNTHETASES IN THE SILK GLAND OF *BOMBYX MORI*. John David Dignam, Shadia Nada, Pei Kan Chang, Hong Li, Hong Wu and Yanhong Wu (Department of Biochemistry and Molecular Biology, Medical College of Ohio, P.O. Box 10008, Toledo, Ohio 43699-0008, USA).

The silk gland of *Bombxy mori* exhibits a remarkable adaptation of enzymes involved in macromolecular synthesis to the production of the two major silk proteins, fibroin and sericin. This adaptation includes changes in the concentration and biosynthesis of aminoacyl-tRNA synthetases. The primary structures of alanyl-tRNA and glycyl-tRNA synthetases have been determined by analysis of cDNA and genomic clones and from partial protein sequence analysis. *B. mori* alanyl-tRNA synthetase is structurally similar to the *E. coli* enzyme and to other eukaryotic alanyl-tRNA synthetases. The glycyl-tRNA synthetase, however, cannot be aligned with the corresponding enzyme from *E. coli* and will not aminoacylate *E. coli* tRNA efficiently nor will the *E. coli* enzyme aminoacylate the major isoaccepting $tRNA_{gly}$ species from the silk gland. Glycyl-tRNA synthetase does have limited sequence similarity with eukaryotic threonyl-, histidyl- and glutaminyl-tRNA synthetases in at least two different domains. Two transcription start sites for glycyl-tRNA synthetase separated by approximately 100 nucleotides were detected by ribonuclease mapping; one of the sites is used preferentially in the posterior silk gland.

TRANSLATIONAL CONTROL AT THE ELONGATION LEVEL IN THE SILKWORM. Shin-ichiro Ejiri (Institute for Cell Biology and Genetics, Faculty of Agriculture, Iwate University, Morioka, Japan 020)

Dramatic changes in the rate of protein synthesis are observed during mitosis or aging, by nutrient starvation, heat-shock, or treatment with hormones or growth factors. In many of these cases, specific activities of translational components, primarily, initiation and elongation factors, are modulated by phosphorylation and dephosphorylation. However, physiological functions and molecular mechanisms of these translational controls are to be explored.

We demonstrated that EF-1 of various eukaryotes catalyzing the binding of aminoacyl-tRNA to ribosomes (aa-tRNA binding reaction) has four subunits, α, β, β', and γ. α and $\beta\beta'\gamma$ correspond in function to prokaryotic EF-Tu and EF-Ts, respectively. Interestingly, out of four EF-1 subunits, both β and β', which stimulate exchange of GDP bound to EF-1α with exogenous GTP (GTP/GDP exchange reaction), were phosphorylated by protein kinase similar to casein kinase II. By the phosphorylation, GTP/GDP exchange and aa-tRNA binding reactions were stimulated. The phosphorylation of β and β' is differently regulated in the silk gland. That is, the extent of the phosphorylation of β was correlated with fibroin biosynthesis, whereas that of β' was constant during 5th instar and dephosphorylated on the last day of the instar. We also found the novel RNA which inhibits the phosphorylation of β and β'. With cultured silkworm cells(BmN4), the phosphorylation of β and β' was stimulated by the addition of tumor promoter phorbol ester(TPA).

Factors That Control the Silk Genes Transcription Yoshiaki Suzuki, Masakazu Fukuta, Kenji Matsuno, Shigeharu Takiya, Pin-Xian Xu, Chi-chung Hui, Kaoru Ohno, Toshiharu Suzuki, Hiroki Kokubo, and Xin Xu National Institute for Basic Biology, Okazaki, Japan

We have been studying the molecular mechanisms that control the differential transcription of the fibroin and sericin-1 genes in the silk gland.

Several silk gland factors (SGF-1 to -4, FBF-A1, ZP-P1) are proposed to bind and control the silk genes. The SGF-2 is specific to the posterior silk gland, binds to the upstream C, D, and E regions (enhancer I) of fibroin gene, and is presumed to be composed of the FF1 and FF2. The ZP-P1 is a zinc-finger type protein and binds to the enhancer II in the fibroin intron. Its mRNA is abundant in the posterior silk gland. The SGF-3 is abundant in the middle silk gland, binds to the SC region of sericin gene, and is a POU-domain protein (POU-M1) which accommodates a domain identical to Drosophila Cf1-a. The SGF-1 is abundant in both the posterior and the middle silk glands, and binds to the A and B regions of fibroin gene and the SA region of sericin gene.

The SGF-3 gene has been c'oned and proteins binding to its promoter are being characterized in the hope to decipher the control at the upper hierarchy.

Cellular and develomental regulation of the P25 gene in Bombyx mori silkgland

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The regulation of the gene eneoding the silk protein P25 was studied in vitro and in vivo. Seanning the proximal upstream scquences by rctardation assay techniques led to identify a serics of putative trans-aeting elements that bind to speeifie sequenee motifs. Among thesc, two complexes, SGFB and BMFA were characterized by differential affinity to their target sequenee. SGFB is a silkgland-speeifie nuelear protein present in posterior cells -where the P25 gene is expressed- as well as in the middle silkgland cells. The other, BMFA, is an ubiquitous protein whose status ehanges aecording to the molt-intermolt cyele sinee it is converted into a modified form in coincidenee with P25 gene specifie repression at molting. In vivo assays of the P25 gene make use of the eapaeity of transgenie Drosophila to express this gone in its larval anterior salivary gland, the silkgland homologue. SGFB- and BMFA-like eomplexes are present in the fruitfly, which argues for their conserved role in genc regulation. Transgenic lines carrying delcted 5' sequenees of the P25 gene showed also that thc -441 to -165 domain is required for expression, probably by proning cell-restricted interactions. Interestingly, combining P25 and fibroin gene upstream sequences led to promote expression of the transgene in different cells of the larval salivary gland and to trigger it in the adult organ. This suggests that the mixed promotor induees specific and positive recognition in a different territory of the Drosophila organ.

EPIZOOTIOLOGY AND CONTROL OF VIRUS DISEASE IN SERICULTURE. Hitoshi Watanabe (NRI, Tokyo University of Agriculture, Setagaya-Ku, Tokyo 156, Japan)

As occluded viruses of the silkworm well retain their infectivities in natural conditions, nuclear and cytoplasmic polyhedroses are apt to be permanently epizootic in a sericultural firm without a thorogh disinfection. Therefore, complete disinfection of rearing house is basically necessary for prevention of polyhedroses.

We found that many of the mulberry pyralids, Glyphodes pyloalis, infesting mulberry plantations, are infected with a nonoccluded viruses in a chronic state in their midgut epithelia, which are serologically identical to the Bombyx IFV and DNV. When silkworm larvae were inoculated with Glyphodes nonoccluded viruses, they developed histopathologically typical infections of IFV and DNV, suggesting that Bombyx nonoccluded viruses. Epizootiologically, the mulberry pyralid is a habitual host of Bombyx nonoccluded viruses. Accordingly, for the control of IFV and DNV, rearing resistant variety or larval rearing by artificial diet is significantly effective to inhibit vertical transmission of Glyphodes nonoccluded viruses to the silkworm.

RECENT ADVANCES IN SILKWORM VIROLOGY. Shigetoshi Miyajima (Faculty of Engineering,Mie University,Tsu,Mie 514, Japan)

In silkworm virology, rapid advances followed the development, in the late 1980's, of techniques for molecular biology of the gene and cell. The recent studies by many researchers about nuclear-polyhedrosis(NPV), cytoplasmic-polyhedrosis(CPV), infectious flacherie(IFV) and densonucleosis(DNV) viruses, are summerized as follows:

Baculovirus expression system are applied to protein engineering in medical, pharmacological and other field. The polyhedrin gene sequence analysis of the CPV between two different shaped types are carried out and suggested that the difference of polyhedron shape is depended on an amino acid change by one point mutation of triplet codon. On the CPV strain A which crystallines in the nucleus it is demonstrated the transmembrane signal peptide as present in the NP gene. The understanding can be aquired on the physicochemical properties such as nucleic acid, protein etc. of the four viruses tried and succeeded to grow for insect cells in media in vitro. As result, silkworm cell-virus interactions can be analyzed this method at cell level. In order to protection the viral diseases, the studies on inhibition by high temperature are carried out as well as some diagnostics of the disease. Several chemicals have been used more or less successfully in trials, either prophylatic agents or as inhibitors of virus (IFV) multiplication. Molecular evolution studies are conducted in DNV.

STUDIES ON SEROLOGY OF THE PATHOGENIC FUNGI OF THE SILKWORM, BOMBYX MORI L. Liangen Shi (Zhejiang Agricultural University, Hangzhou 310029, China)

The serological basic properties and difference of the pathogenic Beauveria bassiana (White types and yellow types) of the silkworm, Bombyx mori were analyzed by agglutination tests and reciprocal absorption tests in this study. The conidia and blastospores of the two types (white and yellow) of B. bassiana were purified respectively by differential centrifugation. Babbite were immunised with the HCHO-Killed conidia or blantospores by intravenous injectons to make the specific antiserum. The conidia and blastospores of the B. bassiana (white and yellow) had good antigenic, but the antigenic of the blastospores was better than the antigenic of the conidia, agglutinin titer of anti-blastospores serum against blastospores were 50-100 times higher than agglutinin titer of anti-conidia serum against conidia. Blastospores of the two types of B. bassiana and their antiser were used for the reciprocal agglutination tests and reciprocan absorption tests, crossreactions and specific reactions were observed between the two types (white and yellow) of B. bassiana of the silkworm in classification, but also would have the most effect on resources investigation and strain classification of the pathogenic fungi of the silkworm, B. mori.

RECENT ADVANCES IN SILKWORM PROTOZOOLOGY. Takeshi Kawarabata (Institute of Biological Control, Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Microscopic inspection of the silkworm mother moths has long been used to diagnose the pebrine infection of silkworm eggs since Pasteur established the egg raising by cellular method. However, many microsporidians other than Nosema bombycis were isolated from silkworms and identification of the microsporidians using spore morphology became hard to utilize. In recent years, immunological methods have been studied to detect microsporidian spore antigens and monoclonal antibody sensitized polystylene latex was highly efficient for the identification of microsporidian spores when the latex adhesion method was employed.

Possibility of in vitro culture of microsporidians was investigated and they could be cultured only in living cells because these organisms lack mitochondrion. Among lepidopteran cell lines, Grace's Antheraea eucalypti cell line has been highly useful for supporting the continuous propagation of silkworm microsporidians in vitro. Synchronous infection of insect cell cultures was accomplished by the inoculation with artificially germinated spores of the microsporidians. Also, several clones of N. bombycis were established applying the similar techniques in A. eucalypti cell cultures.

Transmission of microsporidian infection in vitro was also determined by electron microscopy. Intracellular germination of so called short coiled spores produced sporoplasm like germs causing infection of new host cells.

STUDIES ON ENVIRONMENTAL ECOLOGY OF SILKWORM PATHOGENS. Huang Ke-wei, Lu You-hua(The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang 212018, China)

In this article, dynamic fluctuations of silkworm fungal pathogens and Cytoplasmic Polyhedral Bodies(CPB) remaining and distributing in silkworm rearing environment are reported. Silkworm pathogenic fungi spread widely in natural environment. In silkworm rearing period, types and seriousness of fungal disease occurrence are positively correlated to the distribution of pathogenic fungi in air. CPB exists in dust on floors which have been used for rearing, on used rearing tools and mountages, and in pools with stagnant water near a rearing house. Fixed survey on dynamic fluctuations of CPB in surface earth of rearing floors in countryside showed that, within one cycle of rearing, a large amount of CPB exists before house sterilization, it is reduced after house sterilization and rises as silkworms grow. Within a year, it rises as crops of silkworms increase. This article also probes into factors affecting both pathogens' infectivity to silkworms---(1) Pathogens' infectivity weakens naturally. (2)Effect of disinfectants, physical and chemical factors etc. (3)Effect of temperature and humidity of ecological environment. (4)Effect of spreading conditions. In addition, soil in the surroundings of rearing houses with high organic matter and moist content is favorable for pathogenic fungi remaining. It increases disease infection on silkworms.

PROGRESS OF STUDIES ON SILKWORM DENSONUCLEAR VIRUSES, Cai You-min(The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang, 212018, China)

This article briefly presents major progress of studying silkworm densonuclear viruses. It includes: 1)Classification of silkworm desonuclear viruses; 2)Physical and chemical characters of silkworm desonuclear viruses; 3)Infection pathology of silkworm desonuclear viruses; 4)Diagnosis of silkworm desonuclear virosis; 5)Effect of physical and chemical factors on the viruses' antigenicity and pathogenicity; and 6)Resistance of different silkworm races to desonuclear viruses and its hereditary regularity.

A SIMPLE AND EASY MICROINJECTION TECHNIQUE FOR INSECTS. Guang-jeng Liaw (Taiwan Apicultural and Sericultural Improvement Station, 261 Kuan-Nan, Kung—Kuan, Miaoli, Taiwan, China)

Microinjection at microliter level is a useful technique for insect physiological and phathological studies. Commercially available microsyringes with needles of large diameter tend to harm the insect and result in the leakage of injected sample. Also they are too expensive to be used for large number of samples and avoid cross contamination. A calibrated micropipette attached to a common syringe with a Teflon tube as adapter was made into a simple, autoclavable and disposible microinjection tool. Silkworms were anesthetized by immersing in water (27^0 C) for 20 min and 0.1% neutral red could be included to the sample for easy detection of leakage. Five microliters of nuclear polyhedrosis virus (BmNPV) suspension was successfully injected into hemocoel of newly exuviated silkworm larvae of 5th instar, with error less than 0.2ul. Larvae thus injected with plaque - purified wild type or recombinant BmNPV showed symptoms at 4 days postinjection, and most of them died at 5th and 6th day.

STUDIES ON A CLONE OF TETRAGONAL POLYHEDRON OF Bombyx mori NUCLEAR POLYHEDROSIS VIRUS AND ITS CHARACTERES. Chen-liang Gong,Chan-le Chen(Suzhou Sericulture College,Suzhou 215151,China),Keng-ming Lu(Huanan Agriculture University,Guangzhou 510642,China),Mintang Li (UMDNJ-New Jersey Medical School,USA)

By using a plaque technique for culturing silkworm cell in vitro, a Bombyx mori nuclear polyhedrosi virus ($BmNPV_h$) was screened to obtain a representative tetragonal polyhedron clone strain($BmNPV_t$).The results in the present experiment show that the symptomy and cell pathological changes of silkworm infected with the $BmNPV_t$, its occulted stage and the target tissue, and multiplication in the body, and its pathogenicity to the silkworm were no diverse from a nuclear polyhedrosis virus hexagonal polyhedron strain ($BmNPV_h$). It is indicated with the serological reactions that was a common antigen determinant in the both $BmNPV_t$ and $BmNPV_h$ but not among the $BmNPV_t$ and the tetragonal BmCPV(CPV_t), the hexagonal BmCPV(CPV_h) , BmDNV and $BmCPV_{sn}$(CPV nuclear embeded strain to be found at Suzhou). The polyhedrin of $BmNPV_t$ was homologous to that of $BmNPV_h$, while the former was vary from the later in the constitutes and stablization to acidic and alkali solution. The digestion pattern for the $BmNPV_t$ -DNA revealed that there was a slightly diverse from a Suzhou strain, Zhenjiang strain and Japan strain of BmNPV.

LATENT VIRUS ACTIVATION AND CROSS-INFECTION OF CYTOPLASMIC POLYHEDROSIS VIRUSES FROM DIFFERENT HOST INSECT SPECIES. Ji-fang Qian, Hong-sheng Lü, Yong-qiao Zhao (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

It has been well known that CPVs have a wide hostrange. This paper dealt with the genomic profiles of silkworm BmCPV, cotton bollworm HaCPV, pine lappet catterpillar DsCPV and their progeny viruses produced in alternative hosts, obtaining some new informations about cross-infection of CPVs. The distinquishable feature of BmCPV genome profile was characterized by separation into 9 bands containing 10 segments of dsRNAs on PAGE. HaCPV-10 bands 15 segments and DsCPV-similar to BmCPV but 5th, 6th band appeared to be 2 bands respectively. The silkworm was died of cytoplasmic polyhedrosis after inoculationg the neonate larvae with HaCPV or DsCPV. However, The progeny virus produced in silkworm gave the genome profile of BmCPV, but not that of inculum virus HaCPV or DsCPV. Similarly, cotton bollworm died of cytoplasmic polyhedrosis causing by inoculation with BmCPV, and the progeny virus was charaterized by the typical genome profile of HaCPV, but not that of inoculum BmCPV. Results suggested that there were unknown mechanisms of pathenogenesis caused by CPVs cross-infection. One of the probable mechanisms perhaps was that exogenous CPV inoculum activated the lantent virus of alterative host.

INTEGRATED CONTROL OF THE UZIFLY, INFESTING THE SILKWORM *BOMBYX MORI* UNDER TROPICAL CONDITIONS. C.J. Persoons (TNO Institute for Environmental Sciences, Delft, The Netherlands), S.B. Dandin, G. Veeranna, K.R. Nagasundra (KSSDI, Thalaghattapura, Bangalore, India), Kaiser Jamil (IICT, Hyderabad, India)

The uzifly, *Exorista sorbillans* Weid., is a larval endoparasite of the silkworm *Bombyx mori* L. endemic to South East Asia. Up to 1980 the pest was confined to North East India. As there was a long gap between various rearings, the pest was controlled naturally. In 1980 the pest was, by accident, introduced to South India. Within a time span of 3-4 years, the pest spread to all three silk-producing states. This is mainly due to the high density and continuous silkworm rearing. At present, with seasonal variation, 15-20% crop infestation is recorded in Karnataka. Soon after the pest manifested itself, State and Central authorities have taken up control measures. The three institutes, the Central Sericultural Research and Training Institute, Mysore, the Karnataka State Sericultural Development Institute, Bangalore and the University of Agricultural Sciences, Bangalore, undertook intensive research. Based on the information available at the Central Sericultural Research and Training institute, Berhampore, West Bengal, certain actions were initiated. As a result, Physical control measures like the use of nylon nets to keep the flies away from rearing apartments, chemical control by the use of Uzicide and Dimilin, and China Clay to prevent attachment of the eggs onto the worms, were recommended. Due to unhygienic and congested rearing space and the absence of separate rearing apartments, these could not prevent the rapid spread and multiplication of the pest insect. In the second phase of research, more intensive studies were undertaken by the CSR & TI and the Indo-Dutch Co-operation project on Control of the uzifly. The institutes cooperating in the latter are the Netherlands Organization for Applied Scientific Research, TNO, the Indian Institute of Chemical Technology, Hyderabad, and the University of Agricultural Sciences, Bangalore. The ultimate goal of the project is to develop an integrated system to control the parasite, based on the use of hyperparasites and microbes, kairomones, pheromones, and food attractants. In addition, supporting information on various aspects of the parasite (e.g. alternate hosts, seasonal regional incidence, effects of various biotic/abiotic factors, etc.) will be collected.

RECOMBINATION OF THE GENOME WITH PLASMID DNA TRANSFECTED INTO *BOMBYX MORI* CULTURED CELLS. Kazuhiro Okano*, Naoko Miyajima, Naoko Takada, Masahiko Kobayasi* and Hideaki Maekawa (Facul. of Agr., Univ. of Tokyo, Tokyo 113, Japan, Dept. of Technology, NIH, Tokyo 141, Japan.)

Some transgenic animals such as mouse, zebrafish, fruit fly, have been constructed; however, in *Bombyx mori*, a gene introduction system has not yet been established except for transient gene expression in cultured cells and developing embryos. A transformation system is necessary to analyse specific gene expression and to use for production of useful bioactive materials. First, we must have evidence of recombination events in cultured cells of *B. mori*. In case high recombination rates are needed, the use of reiterated sequences is better as vector. We have chosen the sequence that we isolated, designated as BMC1, which exists in more than 3000 copies per *Bombyx* haploid genome and is presumed to belong to the L1 family derived from a retroposon. We constructed a transforming vector by using a BMC1 sequence together with the hsp70 promoter of *Drosophila melanogaster* and chloramphenicol acetyltransferase (CAT) linked to an SV40 terminater as a reporter gene. After about one month culture, four recombinant clones were screened from about $1x10^6$ cosmid clones constructed from DNA isolated from transfected cells. One clone contained a unique sequence derived from the *Bombyx* genome. Another two clones recombined with BMC1 sequences which were different from the transfected plasmid.

TRANSIENT EXPRESSION AND FATE OF DNA INJECTED INTO EARLY EMBRYOS OF THE SILKWORM, *BOMBYX MORI*. Toshiki Tamura, Toshio Kanda, Kenji Yukuhiro (National Institute of Sericultural and Entomological Science, Tsukuba Ibaraki 305, Japan)

It is very important subject to construct transgenic silkworm of *Bombyx mori*, not only for silkworm breeders but also geneticist. We have been working problems related to this subject for these recent years. However, many problems still remains to be solved. In this symposium, we talk about our recent works and results.

As a first step, constructing an efficient DNA injection system for the early embryos was important. So, we first developed a convenient and efficient DNA-injection method for *Bombyx* embryos using a tungsten needle and air-pressure. Then, using this injection system and chimeric CAT genes fused with appropriate promoters, we developed a transient gene expression system in early embryos. Characterization of this system showed that the expression was detected only when the CAT gene injected before the early nuclear cleavage stage. In addition, comparison of promoters showed that promoters originating from insect genes, like the *Bombyx* fibroin and *Drosophila* hsp70 genes, functioned as strong promoters. We are also studying the fate of injected DNA and analyzed factors affecting the persistence of DNA during the development. Comparison of the persistence of injected DNA between linear and surpercoiled DNA showed that supercoiled DNA persisted a little bit longer than linear DNA.

BACULOVIRUSES AS MOLECULAR TOOLS FOR PROBING INSECT GENE FUNCTION. R. Johnson, W. Qiu, M. Lu and K. Iatrou. Department of Medical Biochemistry, University of Calgary, Canada.

Nuclear polyhedrosis viruses (NPVs) infect a wide variety of insects and are of considerable interest for their value as gene expression systems and their potential as agents for biological control of pest insects. We are using Bombyx mori NPV(BmNPV) as a model for studies on the molecular biology of baculoviruses, their development into agents that may mediate insect embryo transformation and their employment as biological pesticides. Our studies on the identification of factors that control host range specificity have revealed that expression of genes present on specific fragments of the genome of Autographa californica NPV(AcNPV) allows replication of BmNPV in Spodoptera frugiperda cells which are normally non-permissive for BmNPV replication. We have also shown that BmNPV can be employed as a transducing vector permitting developmentally regulated expression of silkmoth chromosomal genes in infected animals. Novel engineered versions of BmNPV deficient in specific late functions are currently investigated for their inability to kill infected silkworms and their capacity to direct transgene integration into the host genome and transmission into progeny. Finally, we are examining the consequences of ectopic neuropeptide expression in silkworms infected with recombinant BmNPV containing the corresponding genes in the context of an expression cassette which becomes transcriptionally active in all silkworm tissues immediately upon infection. These studies will be summarized and future prospects will be discussed.

EXPRESSION OF TRICHOSANTHIN IN SILKWORM LARVAE INFECTED WITH A RECOMBINANT BACULOVIRUS, BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS. Rui-yin Chu, Yu-lian Lin, Nai-sui Pan and Zhang-liang chen (National Laboratory of Protein Engineering and Plant Genetic Engineering, Department of Biology, Peking University, Beijing, 100871, China)

Trichosanthin is a 26-kDa plant-drived ribosome-inactivating protein with potent inhibitory activity against human immunodeficiency virus (HIV) in vitro. The trichosanthin gene had been cloned from the genomic DNA of Trichosanthes kirilowii Maximowich by PCR amplification. The amplified DNA fragment encoding for a protein with 270 ammino acids including a putative signal peptide of 23 aa had been inserted into a new BmNPV transfer vector. Bm-N cells were co-transfected with the recombinant transfer vector and the authentic BmNPV DNA. Through homogeneous sequences recombination in the cell, a recombinant virus harboring trichosanthin gene had been selected and purified by plaque assay. Silkworm larvae infected with the recombinant virus on the first day of the fifth instar produced significant amounts of trichosanthin protein, five days after infection. The recombinant trichosanthin synthesized in the hemolymph was analyzed by SDS-PAGE and detected by western blotter using a rabbit anti-trichosanthin antiserum. It is interesting that silkworm infected with recombinant virus showed delaying of disease symptom development comparied with wild BmNPV. This may be due to the antiviral activity of the expressed trichosanthin. The work of studying the structure-function relationship of trichosanthin and improving its value in application using baculovirus expression system is in progress.

HIGH LEVEL EXPRESSION OF FOREIGN GENES IN BoMo-15AIIc INSECT CELLS AND IN SILKWORM LARVAE USING A BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS EXPRESSION VECTOR. Jun Kobayashi, Shuichiro Tomita, Shigeo Imanishi, Hajime Inoue (National Institute of Sericultural and Entomological Science, Ibaraki, Japan), Toshimichi Kanaya (Research Institute for Biological Science, Katakura Industries Co.,Ltd., Nagano, Japan), Kazuhiro Ohsuye (Suntory Institute for Biomedical Research, Osaka, Japan)

The Bombyx mori nuclear polyhedrosis virus (BmNPV) vector system is an extremely useful system for the expression of foreign genes at the high levels not only in insect cells but also in silkworm larvae. In most cases the biological activities of recombinant proteins expressed in this vector system are similar to the authentic proteins. We have established a cell line NISES-BoMo-15AIIc from B. mori embryos. We also constructed several transfer vectors for foreign gene expression using recombinant BmNPVs. First, our BmNPV vector system was evaluated using a Xenopus laevis C-terminal α-amidating enzyme (AE-II) gene. The enzymatically active AE-II was successfully expressed and was identified predominantly in the culture medium and the hemolymph of silkworm larvae. The level of recombinant enzyme in the larval hemolymph at 4 days post-infection (40 μg/ml) was more than 100-fold the peak levels found in the culture medium (250ng/ml). Subsequently, we have succeeded to express several other foreign genes using this BmNPV system. However, one foreign gene product, which was expressed at the high level, proved to be insoluble and biologically inactive.

EXPRESSION OF THE HUMAN -IFN GENE IN S. FRUGIPERDA AND BOMBYX MORI CELLS. Jialu He (The Sericultural Research Institute of the Chinese Academy of Agricuttural Sciences, Zhenjiang 212018, China)

A transfer plasmid pAPIFN was that the entire human -interferon gene was inserted pAc373 BamHI site. The SF21 cells were co-transfected with pAPIFN and wild-type AcNPV genomic DNA. A recombinant virus AcNPVIFN was obtained by plaque assay. Southern blot revealed that the recombinant virus contained the -IFN gene sequence. 2.6×10 U/ml of the human -IFN activity was produced in the SF21 cells infected with rAcNPVIFN. A transfer plasmid pBE284 EcoRI site. The Bm5 cells were co-transfected with pBEIFN and authentic BmNPV DNA. A recombinant virus BmNPVIFN was isolated and purified by plaque assay. The rBmNPVIFN was injected into 5th instar Bombyx mori larvae, and high expression of the human - interferon activity was obtained from the haemolymph.

POLYHEDRIN GENE OF CHINESE OAK SILKWORM (Antheraea pernyi) NUCLEAR POLYHEDROSIS VIRUS AND IT USE AS A BACULOVIRUS EXPRESSION VECTOR. Chun-fa Zhang,Qi Fan Shu-san Liu, Yu-wen Hu,Wen-li Li, Lin-mei Wang, and Guang-ze Li (Laboratory of Biotechnology, Liaoning Silkworm Research Institute, 75-3, Fuchun Xiaoqu, Dandong, Liaoning, China.)

A portion of Antheraea pernyi nuclear polyhedrosis virus genome which containing the gene encording the polyhedrin proteins has been cloned.The nucleotide sequence of entire coding region of polyhedrin gene together with some of it's 5' and 3' flanking sequences have been analysed and it's transcription start site was determined. For production of non-fused proteins in insect cells, a series of transfer vectors, pAp M 2614, 261, 268, 74, 741 and 748 were constructed by methods of site-directed mutagenesis and polymerase chain reaction. For determination of expression function of these constructed transfer vectors, some of foreign genes were inserted into the vectors of pAp M 2614,74,741 748 and did the cotransfection. The foreign genes were expressed by all these vectors and it's seem to be that the expression level of the vector,pAp M 741, 748 was higher than that of pAp m 2614 and 74.

SEQUENCE ANALYSIS OF THE POLYHEDRIN GENE OF A BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS. I. POLYHEDRIN MORPHOLOGY MUTANT AND CONSTRUCTION IN AN UNIVERSAL EXPRESSIBLE VECTOR. Rui-yin Chu, Qin-hua Wang, Yu-lian Lin, Nai-sui Pan and Zhang-liang Chen (National Laboratory of Protein Engineering and Plant Genetic Engineering, Department of Biology, Peking University, Beijing 100871, China)

A morphological mutant with cubic plyhedra had been isolated from wild BmNPV by plaque purification technique. The virus DNA was digested with EcoRI and cloned into bluescript. Five clones containing polyhedrin gene were selected. The inserted 10.6Kb EcoRI fragment was mapped and an additional Xho I site was found upstream to the polyhedrin gene. The polyhedrin gene has been sequenced entirely together with some 5' and 3' flanking sequences. Comparison of the nucleotide sequence with BmNPV T3 isolate revealed that a single point mutation occurred within the polyhedrin coding sequence. This point mutation caused a substitution of valine by methionine at amino acid 156. The valine at amino acid 156 was also found in another BmNPV isolate and AcNPV E2 strain which appeared normal polyhedra. These results showed that the morphological change of polyhedra was not caused by a single amino acid replacement. Some other factor may be responsible for polyhedrin protein accumulation and involved in the polyhedrin morphological mutation.

By suing PCR mutagenesis technique, a new transfer vector has been constructed with the 10. 6 Kb EcoRI fragment. A Hind III site was introduced in place of the start coden ATG(ATG→AAGCTT).

CLONING AND SEQUENCING OF P10 GENE FROM THE BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS. Yaozhou Zhang, Ying Zhang, Xiangfu Wu, Hongsheng Lu, Zaiping Li (Shanghai Institute of Biochemistry, Academia Sinica, Shanghai 200031, China)

A P-labeled cloned DNA fragment (AcMNPV EcoRI-P) containing the P10 gene from Autographa californica multicapsid nuclear polyhedrosis virus (AcMNPV) was used to probe Southern blots containing restriction endonuclease digests of Bombyx mori nuclear polyhedrosis virus DNA. The fragments of 0.5 and 1. 1kb were hybridized and cloned into pUC18. The 1. 1kb fragment was mapped with restriction endonucleases, and reprobed with the AcMNPV EcoRI-P fragment. Two small regions of about 200bp and 700bp were cross-hybridized. DNA sequencing in these regions showed an open reading frame of 285bp which shared detectable homology with the P10 gene of AcMNPV. The 5'-and 3'-flanking regions had been sequenced. It was revealed that the BmNPV P10 gene could code for the P10 protein which had 93 amino acid residues. The homology of the nucleotide sequences of P10 structural gene and the amino acids sequences of P10 protein between BmNPV and AcMNPV reached 95% and 88%, respectively. A comparison between the 5'-and 3' - flanking sequences of the AcMNPV and BmNPV P10 genes had been made. This study may provided the bases for further understanding the function of the BmNPV P10 gene promoter, and constructing the expression vectors controlled under the P10 gene promoter.

CLONING THE PROMOTER REGION OF FIBROIN H-CHAIN GENE OF *BOMBYX MORI* BY POLYMERASE CHAIN REACTION. Wei-Min Wang,Rong-Xiang Fang*,Zhi-Qi Meng,Ke-Qiang Mang*(Center of Biotechnology,Zhejiang Academy of Agricultural Science,Hangzhou 310021,China; *Institute of Microbiology,Academia Sinica,Beijing100080,China)

The 5' flanking sequence of the *Bombyx mori* fibroin gene exerts promoter(-29 to +6 region)and enhancer(-238 to -32 region) functions for its gene expression. Here, we amplify the -552 to +22 fragment by PCR from the total DNA of the silkglands of Chinese silkworm D13. After digested with PstI and NcoI enzymes, the PCR fragments are cloned into pGEM5Zf (+) vectors,then they are transfected into XLI-blue cells,Three recombinants,Bm-1, Bm-3, Bm-7, remain the inserted segments, which are sequenced and found to be identical exactly. Compared with the similar sequence of the Japanese silkworm Gunka×Hoshun,the PCR fragment sequence accordancy rate is 97.6%. The different nucleotides are mainly distributed in the upstream of the fragment, while there is no difference in the regions responsible for transcription regulation. So we can conclude that the cloned fragments are the promoter and enhancer regions of the fibroin gene. Owing to its unusual regulating ability, this fragment will be very potential for constitution of some mosaic genes utilizing the fibroin geng expression system.

MULTIPURPOSE UTILIZATION OF SERICULTURAL RESOURCES IN CHINA. Ziran Huang (South China Agricultural University, Guanzhou 510642, China)

1. Silkworm feces utilization: The pigments were extracted from the feces with actone or gasoline, the solvent was recovered and saponified, the product is known as chlorophyllin. The nonsaponified fraction contains the materials such as beta-carotene, phytol and triacontanol. chlorophyllin and carotene were used as food additives and medicine. Phytol was used to synthesize Vit E and K. Triacontanol is a plant growth regulator.

2. Silkworm pupae utilization: Pupal oil contains unsaturation fatty acid more than 70%, linolenic and linolenic acids were used as nutrient oil. When the pupal oil was hydrolized with alkali or estrase, the unsaturation fatty acid was obtained. Pupal protein contains the essential amino acid more than 36%. Lysozyme can be developed from haemolymph of Chinese oak siliworm pupae by heat shocking, the affinity chromatography method with chitin coated cellulose was used to separate the lysozyme.

3. Silk product utilization: Cocoon and silk were used to extract serine, sericin, fibrion which were used as good resources for cosmetics.

4. Silkmoth utilization: The famous druggist Li Shi Zhen in Ming Dynasty wrote in his book "Compendium of Materia Medica": silkworm, pupae, moth, cocoon and feces were used in chinese medicine, Which contained constiuents such as testosteron, female sex hormone and prostaglandins etc.

A STUDY ON THE EXPLOIT AND MAKING USE OF CORDYCEPS MILITARIS IN JILIN PROVINCE. Huansheng Gu, Manyi Liang (The Research Institute of Sericulture. Jilin 132200. China)

Cordyceps militaris is a valuable ingredients of traditional Chinese medicine. C. militaris similar with C. sinensis is a kind of famous biological medicine. But the wild kind of them are dificient in resources.

We've got a strain by separating and purifing from wild C. militaris that is from ChangBai Mountain. We use the strain to inoculate into pupos of Antherea pernyi, Bombys mori and Diatraea crambidoides, etc. The cultured sporophores are grown or then that are the same with natural C. militaris on morphological characteristic. Simultaneously, we study biological characteristic of it, get the best condition for culture and master the inoculated technique for reproduction. Besides, the wild host of C. militaris is bred and identifed. The invention patent was published by Chinese patent bureau in Aug. 2, 1989. According to the medical chemistry, medical physics and poison substances analyzing result, the man-made C. militaris of silkworm has not only poison but has obvious action in medicine.

C. militaris of silkworm has not only used on the medical, but also used in the drinks, foods, chemical industry goods for daily use and biological control. That has vast vitas if it is exploited and made use of.

PEPTONE PREPARATION FROM SILKWORM PUPAE. Hong-ji Xue, Hua Ding, De-xin Yang, Xu Guo, Yu-hong Wang (Jiangsu Institute of Microbiology, Wuxi 214063, China), Sheng-guo Zhu, Hong-hai Chen, Hong-bin Chen (Rudong county Biological Products Factory)

This paper focuses on the study of making odorless, yellowish peptone from silkworm pupae by enzymolysis. 75 Kg defatted silkworm pupa powder was hydrolyzed with 6 Kg crude neutral protease at PH 7-8 and 40-50℃ for 10 hours, then separated, decolourized, concentrated and spray-dried to obtain about 30 Kg peptone. The availabilities of the pupa peptone to some industrial fermentations have proved that it's well-matched with the fish peptone, such as the productions of Micromicin Inosine and Wei-Mei-Su (Riboflavin Complex), etc.

FISH LINE SILKWORM IN SOUTHERN JIANGXI. Jialong Liang, (Zhejiang Institute of Silk Textiles, Hangzhou 310033, China)

There are three subbreeds of fish line silkworm in China Ericyna pyretorum pearsoni Westwood, Staturia (Erigyna) pyretorum cognala jordan and S. (E.) pyretorum luciferaordan. In 1985, the author made an investigation on fish line silkworm in southern Jiangxi Province, China, all belonging to Staturia (Erigyna) pyretorum pearsoni. There the making use of fish line silkworm for fish line and absorbable suture was famous at home and abroad. The process of making line is detailedly described and the composition of its fibroin amino acid also given in the present article, the latter shows that the line is more easily absorbed by biological enzyme than that of mulberry silkworm and so throw a ray of light on its development.

STUDIES ON CHEMICAL COMPOSITION AND NUTRITION OF SIX SILKWORM CHRYSALISES: I . ANALYSIS OF 20 MAJOR AND MINOR ELEMENTS IN SIX SILKWORM CHRYSALISES, Li Zheng (Hangzhou Silk Printing & Dyeing Joint Plant, Hangzhou 310015, China) , Shao Yuanping(Heilongjiang Sericulture Direction Station), Shan Fang(Shanxi Academy of Agricultural Sciences) , Cao Meixun(Shanghai Entomology Research Institute, Academia Sinica), Li Meiqui(Hangzhou Silk Printing & Dyeing Joint Plant, Hangzhou 310015, China), Li Ping(Shanxi Academy of Agricultural Sciences)

Twenty major and minor elements of 6 silkworm chrysalises were tested. It was found that the 6 silkworm chrysalises all contained a high level of zinc, averaging 16.5mg/100g. In comparison with Chinese rice, 78 kinds of common food in Xuzhou District, and 128 kinds of common food in Chengdu District, silkworm chrysalis is a food with the highest content of zinc. The nutritive value of the minor element zinc in silkworm chrysalis is explained.

A STUDY ON THE MECHANISM OF BACTERICIDAL EFFECT OF ANTIBACTERIAL PEPTIDE FROM CHINESE OAK SILKWORM (ANTHERAEA PERNYI). Wen-chu Li, Kengming Lu, Ziran Huang (South China Agricultural University, Guangzhou 510642, China)

Experimental evidents show the inducible antibacterial peptide (AP) developed from the haemolymph of Chinese oak silkwrom (Antheraea pernyi) pupae by injecting with E. coli K12D31. AP was purified by CM-Sepharose CL-6B and Phenyl-Sepharose chromatography.

The pathogens of rice bacterial blight (Xanthomonas campestris pv oryzae) and tobacco bacterial wilt (Pseudomonas solanaceaum) were killed by AP, respectively. Ultra-thin section technique was used to study the mechanism of AP bactericidal effects. We discovered its primary targets were the bacterial outer layer and cell membrane, the effect is most evident sensitive at the both ends. At initial action stage, the receptor sites were seriously injured and small channels were observed. Intercellular substances were pressed out off the cell subsquently, the cell became a empty vesicle, but the cell was not show collapsing morphology.

POPULATION ECOLOGY OF ANTHERAEA MYLITTA DRURY (SATURNIIDAE : LEPIDOPTERA)

K. Thangavelu and A.K. Sinha
Central Tasar Research and Training Institute,
Ranchi 835303, India

Antheraea mylitta Drury, the tropical tasar silkworm is widely distributed in tropical region, particularly in the deceduous and semideceduous forest. Wider distribution and polyphagy of the insect have resulted in extensive variation in the population and there are nearly 28 eco-races distributed almost between 24° and 16° latitude and 80° - 88° longitude. This range provides a wide variation in ecological conditions leading to natural variation in different population groups.

A high degree of morphological and genetic heterozygosity has been observed in the natural population of A. mylitta. The level of genetic diversity between races is well established. Adaptation to different ecological conditions appear to be the major source of diversity as ecological factors influence genetic variability. The variability is very well reflected in biological, quantitative and behavioural characters.

Signicance of genetic variability among eco-races and the importance of such variation for improvement of tasar culture are discussed along with colour polymorphosism in the larvae and cocoon.

OBSERVATION ON BIOLOGICAL CHARACTERISTICS OF ANTHERAEA YAMAMAI USSURINSIS.

Feng Shengzu, Zhang Tao, Feng Lingyun (Shenyang Agricultural University, Shenyang, China110161)

1. Egg stage, The egg stage of Antheraea yamamai ussurinsisis 5--25 days longer than Japanese oak silkworm(A. yamamai). But the egg incubation period of A. Yamamai ussurinsis is 4 days shorter than that of A. yamamai after eggs taken from 0-2℃. We first found that diapause eggs of A. Yamamai ussurinsis have early termination of diapause phenomenon. When the preservation eggs temperature is 11℃ in November, the hatchability reached 0.7% until the mid-November. The hatchability of 0.7% is lower than the hatchability of 37.8% in Hangzhou, Zhejiang province in late-December. 2. Larval stage, When A. yamamai ussurinsis larvae were reared in the late of April in Shenyang, the larvae were general four-molter (fifth instar). There were very few three-molter(fourth instar) larvae in some years. When the larvae were rear-ed in the mid-May, sometimes there were a few five-molter (sixth instar) larvae. For the first time, it was found that the west of Liaoning is very suitable for A. yamamai ussurinsis development. The cocooning rate was as high as 60-92%.

STUDIES ON MECHANISM OF HIBERNATION OF ERI-SILKWORM(PHILOSAMIA CYNTHIA RICINI).

Ting-yin Liu, Dong-jie Li(Institute of sericulture, Hebei Academy of Agriculture and Forestry Sciences, Chengde 067000, China)

1. The level of nutrient metabolism: the content of dry matter, carbohydrate and fat in bibernating pupae of Eri-silkworm is relative higher than that of non-hibernating pupae, but the reserves of protein is very low, equal to the natural hibernating pupae. 2. The effect of pupae brain: Hibernating pupae's brain had a key effect on controlling and regulating the development. The content of the hibernating pupae's brain hormone(BH) is too low to initiate the development of pupae before the critical period (pupae stage 70th days). 3. Growth and decline of hormone: (1) The tame strain and the strain of P. C. ricini X P. Cynthia can be induced the internal dormant character in the " late-autumn-like" environment. (2) Either the strain of P. C. ricini X P. Cynthia or the tame strain, if being reared under normal environment, secrete MH as usual after pupating. (3) That MH of hibernating pupae is very low through 70 days. (4) The cultivated strains have acquired some kind of information that restrains secretion of BH before pupation. (5) The growth and decline of MH identify of cultivated strain and the strain of P. C. ricini X P. Cynthia in all hibernation pupae stage.

SILKSECRETIONS AND COCOON FILAMENT FORMATIONS OF WILD SILKMOTHS.

Hiromu Akai and Takayuki Nagashima (Tokyo University of Agriculture, Tokyo 156, Japan)

Ultrastructural characteristics of liquid silk in the silk gland of both Antheraea yamamai and Antheraea mylitta were elucidated. These liquid silks contain various size of numerous vacuoles ranging from 0.1 to 2 um in diameter. Vacuolous structures were also detected in cocoon filaments of both Antheraea silkworms. During the last larval instar of these silkworms, numerous lysosomal bodies are formed in the posterior silk gland cells and released into a silk layer located between the apical cell surface and the cuticular intima. From the observations of silk gland cells in A. mylitta larvae, it was demonstrated that these degenerating lysosomal bodies penetrate into the liquid silk of the gland, and these are origin of the vacuoles. The cuticular intima of the posterior silk gland is usually degenerated and remained the trace as compared with other ectodermal tissues. In these two A. silkworms, degeneration of intima is more advanced than Bombyx silkworm and completely degenarated. Also, it was cleared that the grades of degeneration of the cuticular intima effects for their vacuolar formations in the liquid silk.

METABOLIC BIOCHEMISTRY OF CARBOHYDRATE AND YOLK PROTEIN IN THE EGGS OF THE JAPANESE OAK SILKWORM, ANTHERAEA YAMAMAI, DURING DIAPAUSE AND EMBRYONIC DEVELOPMENT.

Toshiharu Furusawa (Department of Applied Biology, Kyoto Institute of Technology, Kyoto 606, Japan)

During pre-diapause of A. yamamai egg, glycogen content increased from 300 nmoles/egg at oviposition to 600 nmoles on day 3, and thereafter decreased to 140 nmoles until day 7. Trehalose appeared on day 6 and increased abruptly to 60 nmoles on day 8. During diapause, the trehalose was maintained at the levels of 50-100 nmoles in the acclimated egg at 5°C. During post-diapause, trehalose began to decrease, followed glycogen. This result shows that trehalose play a role in cold hardiness and is used as a energy source for embryogenesis of A. yamamai.

Vitellin-H (180kDa) was degraded into 5 polypeptides between 130 and 180kDa on day 8-9 when embryo appeared to enter diapause. The degraded vitellin-polypeptides were observed in the gut juice, and maintained during diapause, but these polypeptides were consumed as larval diferentiation proceeded after the termination of diapause. However, vitellin (180kDa) was detected in embryonic hemolymph, and disappeared just before hatching. The degradation of the vitellin coincided with the appearance of two different proteases in molecular weight on gel of casein SDS-PAGE. Thus, vitellin is degraded at the limited stage of embryogenesis, and the degradation process of the vitellin in hemolymph and gut juice of embryo appear to be different. We will also discuss on carbohydrate metabolism and vitellin degradation, compared with those of Bombyx egg.

PIGMENTS AND CHROMOPROTEINS OF *ANTHERAEA YAMAMAI*

H. Yamada (Yakult Institute, Tokyo 186, Japan), Y. Kato (Dept. of Biology, International Christian University, Tokyo 181, Japan)

In insects, green coloration is due to the presence of a blue component with a yellow component. *A. yamamai* is green not only in larval body-color, but also in the cocoon color. These phenomena may have an important role in cryptic function. We have investigated the color principles of the larval hemolymph and cocoon material stored in the silk-gland. Gel filtration chromatography of the hemolymph showed that the blue component is a biliprotein having an absorption maximum at 665 nm (chromophore: abs. max. 620 nm), whereas, the yellow one is composed of two different pigments, i.e., carotenoid and flavonoid (abs. max. 370 nm). The carotenoid is bound to a protein and the flavonoid is present in free form. For the cocoon material, the blue component is a biliprotein having an abs. max. at 675 nm (chromophore: abs. max. 650 nm). Besides this, a blue pigment in free form was detected which is thought to be a chromophore of the chromoprotein. On the other hand, the yellow component in the cocoon material is protein-bound (abs. max. 390 nm).

ANALYSIS AND COMPARISON OF THE PROTEIN, AMINO ACID AND SERICIN CONTENTS IN COCOON-LAYER OF THE ERI-SILKWORM (PHILOSAMIA CYTHIA RISINI) REARED WITH DIFFERENT FEEDS. Hui-tian Qian, Jian-hui Liu & Da-she Qu (Sericultural Department, Guangxi Agricultural College, Nanning, Guangxi 530005, China)

During 1989 to 1991, we reared two eri-silkworm races: White-yellow and Nanning No. 1, which were breeded by Guangxi Sericultural Institute, with castor (Ricinus communis L.) leaves and cassava (Manihot utilissima Poh. L.) leaves. The experimental results are as follows: 1. The percentage of healthy pupae and the cocoon weight, reared on castor leaves in all instars district gave the highest. 2. Percentage of cocoon layer, protein content, total amino acids, and the percentage of the sericin content in cocoon layer: The 5th instar reared on cassava leaves district gave the highest for both races. So for eri-silkworms reproduction, consideration of the percentage of healthy pupae and the cocoon weight, the insects should be reared with castor leaves for all instars. For silk-spinning, consideration of the percentage of cocoon layer, protein content, total amino acids and percentage of sericin in cocoon layer, the insects should be reared with castor leaves for the 1st to the 4th instar and with cassava leaves for the 5th instar.

IMPROVED REARING ON ARTIFICIAL DIET OF ERI SILKWORM, PHILOSAMIA CYNTHIA RICINI. Osamu Shimizu (Gunma Sericultural Experiment Station, Maebashi 371, Japan), and Hiromu Akai (Tokyo University of Agriculture, Tokyo 156, Japan)

Food plants of Eri silkworm are mainly Ricinus communis and Ailanthus glandulosa which are deciduous plants in Japan. Eri silkworm is also multivoltine so that the artificial diet is indispensable food to continue the rearing through a whole year. We succeeded to produce the improved artificial diet for the multivoltine Japanese Eri silkworm and to continue several generations by the artificial diet. Total feeding duration from hatching to spinning was 20 to 22 days and their developmental status were uniform in Eri culture. Measurable characters of the cocoons were also satisfactory. Average cocoon weight was 2.02 gram and the cocoon shell weight was also 201.5 mg. Average number of eggs laid was 173. From these results, we concluded that the Eri culture with artificial diet is a valuable rearing method for eggs production and their breedings.

REARING OF JAPANESE OAK SILKWORM, *Antheraea yamamai* IN JAPAN. S. Kuribayashi (National Institute of Sericultural and Entomological Science, Tsukuba 305 Japan)

Antheraea yamamai which inhabits in plains and mountainous areas through out the Japanese islands, feeds mainly on leaves of *Quercus* plants. In recent years the rearing area of *A. yamamai* has expanded in Japan. In 1990, 370 farmers harvested about 4.5t of cocoons and about 200 kg of silk was obtained from these cocoons. The larvae were reared as follows; (1)Outdoor rearing: rearing on food plants covered with a net. (2)Indoor rearing on cut shoots: rearing on cut shoots dipped in water in bottles. (3)Indoor box rearing: larvae are introduced into flat bottom boxes with a net on to which picked leaves or artificial diet are placed. Recently the food value of artificial diets has been improved as in the case of fresh plant leaves. *A. yamamai* is univoltine, and usually reared once a year. However if the hibernated eggs are kept at 5°C for more than 3 months, they are able to hatch at any time by incubation. An artificial hatching method for non-hibernated eggs has been developed by dipping eggs into a imidazole derivative solution. By the application of these artificial methods of haching *A. yamamai* can reared at any time throughout the year. Recently, the demand for *A. yamamai* silk is increasing for various uses such as mix-woven textiles, furniture and interior decoration. To promote the development of and to popularrize *A. yamamai* rearing in Japan, the following problems should be addressed.(1)Breeding of superior *A. yamamai* strains. (2)Breeding of food plants. (3)Cultivation of food plants. (4)Mass production of eggs. (5)All year rearing.

SILK PROCESSING OF SEVERAL WILD SILKWORMS IN TAIWAN. Yang-Shan Lin, Tzeng-Cherng Liou, Cheng-Lin Liu, and Yun-Tsong Liou (Taiwan Apicultural and Sericultural Experiment Station, Miaoli, Taiwan, China)

Tussah, camphor and mulberry silk yarns which were degummed by soap-sodium degumming after hydrochloric acid treatment and were dyed with the C.I. acid blue 40. There were large differences in the lightness of the dyed samples. In particular, the chroma of wild silks were lower than that of mulberry silk.

ON THE REARING TECHNIQUES FOR THE JAPANESE OAK SILKWORM, ANTHERAEA YAMAMAI IN EAST CHINA. Cui Hu, Gong-yin Ye and Xiao-jin Wu (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

Different rearing seasons, rearing fodder plants and rearing methods in East China for the Japanese oak silkworm, Antheraea yamamai were systematically compared from 1988 to 1991. The results indicated that: the best beginning period in East China for rearing the oak silkworm was the 1st or 2nd ten day of April, Quercus fabri as the fodder was better than Q. acutissima. From the 1st to 2nd instar, several or more larvae could be gregariously reared in a container so as to take less man-power. In addition, several meridic diets containing the leaf flour of Q. fabri as leaf factor were acquired through twice orthogonal selecting experiments.

Recent Advances of Molecular Biology and Genetics in Silkworms and Their Application to Sericulture

RECENT WORK ON GENE INTRODUCTION INTO THE SILKWORM. Hideaki Maekawa, Naoko Miyajima, Naoko Takada, Kazuhiro Okano*, Masahiko Kobayashi*, Yoshiaki Kikuchi** and Kozo Tsuchida(Department of Technology, National Institute of Health, Tokyo 141, Japan, *Facul. of Agr., University of Tokyo, Tokyo 113, Japan, **Kyodo Shiryo Co. Ltd., Yokohama 244, Japan)

Gene introduction in germ line and cultured cells has been developed in some species. In *Bombyx mori*, a few groups(Calgary, Lyons and Tsukuba) have been testing independent strategies. The first fundamental problem concerns transient gene expression. We have tried transfection of DNA into cultured cells. Plasmid DNAs containing several promoters were transfected into cultured cells by the usual calcium phosphate method and in all cases expression was detected. We do not have retrovirus vectors for transformation in *B. mori*. However, as we have a high copy sequence, designated as BMC1, which is presumed to be derived from a retroposon-like L1 family, random insertions into the genome were tested using a vector containing this sequence. Evidence for recombination events between the transfected plasmid and genomic sequences was obtained by isolating recombinant clones. More improvements are needed to establish a reliable and more efficient transformation system. For direct insertion, injection of plasmids into fertilized eggs is being carried out by other groups. We have also started to construct minichromosome vecters retained more stably in *B. mori*. We will discuss recent results and additional strategies under consideration.

CONSTRUCTION OF A MOLECULAR LINKAGE MAP FOR THE SILKWORM. M. R. Goldsmith and JinRui Shi (Department of Zoology, URI, Kingston, RI 02881-0816, USA).

Among the lepidoptera, genetics is most advanced in *Bombyx mori*, in which more than 200 mutations have been mapped to 28 linkage groups. To develop and strengthen the genetic resources available as a foundation for research in the lepidoptera, and to promote advances in molecular biology, genetics, and practical breeding in the silkworm, an international group of scientists has begun to construct a molecular linkage map in this species.

Our initial goal is to construct a molecular map at 10 centiMorgan (cM) density, requiring approximately 100 evenly spaced markers, given the current minimal map length of 1000 cM. This will allow us to begin the genetic analysis of quantitative (polygenic) traits of economic importance which appear to be well-segregated in bivoltine *vs.* multivoltine strains. Southern blot analysis shows substantial polymorphism between strains and homozygosity within strains, facilitating construction of the map. We will discuss strategies for this project and report on recent progress, including pilot studies with F2 progeny from a cross between Chinese bivoltine (C108) and multivoltine (p50) strains using cloned probes for known, linked and unlinked genes, low copy number repeated elements, and random, cloned cDNAs.

BIOCHEMICAL GENETICS OF CHYMOTRYPSIN INHIBITOR OF BOMBYX MORI. Hiroshi Fujii, K. Shirai, H. Aratake[1], L. R. Deng[1], Y. Kawaguchi[1], K. Koga[1], H. Doira, T. Shinohara[2], and Y. Aso (Institute of Genetic Resouces, Laboratory of Sericulture[1], Genetic Resouces of Biotechnology[2], Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

Following polyacrylamide gel electrophoresis, sixteen distinct components of chymotrypsin inhibitor (CI) have been identified in larval hemolymph of Bombyx mori. They were analyzed genetically and were controlled by each gene on three separate chromosomes (2nd, 19th and 22nd). The gene located on the 2nd chromososme controlled expression of CIs of low molecular weight, the genes on the 19th and the 22th chromosomes made CI of high molecular weight. We pay attention to the gene on the 2nd chromosome. It was a complex gene consisting of three genes, one of these gene regulated the expression of CI-13 and 13' but not null, the 2nd one controlled the presence of CI-1,2, 2' and null, the 3rd one controlled the appearance of CI-9, 10 and null. All silkworms sofar tested have always either CI-13 or CI-13'.

On biochemical analysis, CIs of low molecular weight showed characteristics of protease inhibitor of Knitz type, that is, containing six cysteins, and being stability of both heat and a wide range of pH and showed a common N-terminal amino acid sequence of DKPTT (or DEPTT).

CHROMOSOMAL FRAGMENT RESPONSIBLE FOR GENETIC MOSAICISM OF THE SILKWORM, BOMBYX MORI. H. Fujiwara (Zoological Inst., Fac. of Science, Univ. of Tokyo, Hongo, Tokyo113, Japan)

The mottled striped strains (pSm), which are genetic mosaics induced by X-ray irradiation, have an extra chromosomal fragment of about 2.3 Mb. This fragment carries the larval body marking genes for the p locus on the second chromosomal end, regulating the complicated pattern formation. The mechanism of induction of such a mosaicism is explained by the occasional loss of the chromosomal fragment during some developmental stages. This type of mutant, therefore, is a good material for studying various biological events such as pattern formation, epidermal cell lineage, chromosomal function and etc. In order to isolate both the larval body marking gene and the functional area such as centromere and telomere in chromosome, it is necessary to construct a genomic DNA library specific for the chromosomal fragment in the mosaic strain. Here, I report the gene structure and organization in the fragment and the construction of the genomic DNA library using PCR with adopter ligation.

Amylases of Polyvoltine Silkworm (Bombyx mori) : Variation expression in the Thai local race

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Amylase enyme expression during the larval developmental stages from hatching until pupation were determined. Apparently, the enzyme cyclical activity conformed well with the feeding pattern i.e., being highest at the peak-feeding days. The activities of individual instars, expressed in terms of released maltose/min. mg protein, were equally high except in the first larval stage. The quantitative activity of the isozymes was thus determined on the peak-feeding day of the fifth instar. Of the 24 polyvoltine strains, popularly used by the farmers, 7 were considered as high in their amylase expression (>6 μmol/min. mg protein). The others, except one, were generally moderate (>4 μmol moltose/min. mg protein). These findings were in accord with the ease in rearing of the polyvoltine silkworm races.

DETECTION OF DNA POLYMORPHISM IN BOMBYX MORI WITH USING POLYMERASE CHAIN REACTION. Toru Shimada[1], Haruhiko Fujiwara[2], Tsuyoshi Hasegawa[1], Hideaki Maekawa[3], Masahiko Kobayashi[1] and Hiroshi Fujii[4] (1. Dept of Agrobiology, Univ of Tokyo, Yayoi, Tokyo 113, 2. Zoological Inst, Univ of Tokyo, Hongo, Tokyo 113, 3. Natl Inst of Health, Kamiosaki, Tokyo 141, 4. Inst of Genetic Resources, Kyushu Univ, Hakozaki, Fukuoka 812, Japan)

To construct molecular maps of Bombyx mori and B. mandarina genomes, we adopted two strategies using polymerase chain reaction (PCR). One was a method using a single arbitrary synthetic primer. PCR under a low annealing temperature produced 2 to 10 bands detected in ethidium bromide-stained agarose gel. When we compared the band patterns among many strains of the silkworms, differences in the band patterns were observed in the strains. Now we are investigating the segregation of these polymorphic bands in the hybrids F_2. The other strategy was the mapping of already-known sequences. We synthesized specific primers to search polymorphism in the prothoracicotropic hormone (PTTH) gene and the arylphorin gene among strains. Three and two variants were found in the PTTH gene and the arylphorin gene, respectively. They were distinguished by the sizes of PCR products. Structural analyses of the PCR products revealed that such variations were due to the differences of the intron length of the gene among strains. Crossing experiments with visible mutant strains elucidated that the PTTH gene is located on the chromosome 22.

Both the arbitrarily-primed PCR and the specifically-primed PCR are hopeful methods for Bombyx genome mapping.

FLUORESCENCE *IN SITU* HYBRIDIZATION AS A TOOL FOR GENE MAPPING IN *BOMBYX MORI*. Kozo Tsuchida, Li Rong Deng, Yosuke Kameoka*, Naoko Miyajima, Kazuhiro Okano**, Naoko Takada and Hideaki Maekawa (Department of Technology and *Department of Virus and Rikettsia, National Institute of Health, Tokyo 141, Japan, **Faculty of Agriculture, University of Tokyo, Tokyo 113, Japan.)

There are no morphological and physical chromosome maps in *Bombyx mori*, despite its extensive genetic linkage maps. This means the identification of individual chromosomes (n=28) is not possible at metaphase, when all chromosomes assume an indistinguishable, spherical shape. Recently, an improved pachytene chromosome banding technique has been developed at Kyushu University by staining early embryonic cells. We have established a clear detection system for localization of genes on chromosomes prepared from testis by use of fluorescence *in situ* hybridization (FISH) with fluorescein isothiocyanate (FITC) binding antibody using biotinylated probes. We have detected telomere using telomeric sequences (presented by Dr. H. Fujiwara in this session), and are now testing the localization of single copy genes such as egg specific protein (ESP) and rDNA, which is clustered on specific chromosomes. In addition, high copy number centromeric-ralated sequences were clearly detected on silkworm chromosomes.Used together with chromosome banding, FISH is a very useful tool for analyzing organization of the *B. mori* genome.

STUDIES ON THE COCOON SHELL TRANSFORMING RATES OF THE SILKWORM UNDER DIFFERENT REARING CONDITIONS

Li Li, Chen Xiao-ping, Yan Yu-min, Sun lie (The Semicultural Research Institute, Sichuan Academy of Agricultural Sciences, Nanchong Sichuan 630700, China)

The paper studied the cocoon shell transforming rates of the silkworm under different rearing conditions. The results have shown that cocoon shell transforming rates of same silkworm variety have significant difference in different rearing conditions. At the same time, there is positive correlationship between cocoon shell transforming rate and cocoon layer rate, digestibility, cocoon weight transforming rate. Its R values are 0.6354, 0.9690 and 0.8977 respectively. But there is negative correlation ship between capacity of dry substance eaten and cocoon layer rate, digestibility, cocoon weight trausforming rates, cocoon shell transforming rates. Its R values are -0.6139, -0.9610, -0.9057, -0.9977 respectively.

STUDIES OF THYROID HORMONE ON ITS ACTING ORGANS AND EFFECT ON THE PROTEIN SYNTHESIS OF SOME ORGANS OF THE 5TH INSTAR SILKWORM BOMBYX MORI.

Gang Hua, Jian Zhang (Suzhou Sericulture College, Suzhou 215151, Jiangsu, China)

The experiment is performed on silkworm Bombyx mori into which the ^{125}I-T_4 or ^{125}I-T is injected. We observe whether these labelled hormones can combine with the ten kinds of organs of the insect. The result shows that ^{125}I-T_4 and ^{125}I-T_3 can selectively combine with digestive gut, muscle, malpighian tube, middle and posterior silkglands among which the combination rate with posterior silkgland is the highest. In addition, I-T_3 can combine with fat body.

Furthermore, the effect of thyroid hormone (T_4, T_3) on protein synthesis of some organs when the hormone is injected into the 5th instar. The result shows that the hormones can enhance the protein synthesis of hemolymph, posterior silkgland, and fat body, but inhibit that of midgut, in which T_3 has more effective than T_4 Other discoveries of our experiments are the opposite effect to the early response at the 3rd and 4th day after injection T_3 or T_4 and the death of the insects which are treated with the high dosage of T_4. So, the thyroid hormones in certain rangs can regulated the protein synthesis and metabolism of silkworm Bombyx mori. in some organs.

A PRELIMINARY STUDY ON THE MAGNETIC EFFECT ON THE DEVELOPMENT OF SILKWORM.

Shan Sun, Ying Huang (Jing Shan School, Beijing 100006,China)

It is indicated that there are dissimilar effects of different magnetic intensities on the development of silkworm Bombyx mori L. in different stages. Under appropriate magnetic intensity treated in suitable stage, the hatching and development of silkworm are accelerated, its cocooning time is advanced, and the vitality of larvae and cocoon shell rate are enhanced. Furthermore, the silk quality will be improved due to the increased male ratio in next generation. It is possible to get the optimum magnetic effect on silkworm rearing for raising the silk production and quality, after further improvement of laboratorial condition and more experimental works to be done.

CHAWKI REARING CONCEPT AND ITS ADOPTABILITY FOR TROPICAL CONDITIONS

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Young age silkworm (chawki) rearing on a scientific basis has been accepted as the most important component for a successful silkworm crop under tropics. Environmental fluctuations and unhygienic conditions during chawki rearing in the dwelling house have been attributed to major crop losses in India. Realising this, the concept of Chawki Rearing Centres (CRCs) was brought in. However due to huge demand for silkworm eggs round the year; continuous rearing and high density of farmers, the demand could not be met with in addtion to the other inadequacies of CRCs. Under the circumstances, an alternate technology, i.e., 'Isolation Chamber' was developed and introduced for chawki rearing. The essence of this system is easy to adopt, minimum initial investment, low operational cost and crop stability with good cocoon yield. This method has been tried in large scale at field level. Further, the details on prospects and problems of CRCs and use of Isolation Chamber at field level are discussed in this paper.

A STUDY ON THE REARING METHOD OF SILKWORM (1-3RD INSTAR) BOMBYX MORI-FEEDING ONE TIME A DAY.

Ron-zhong Yang (The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang, Jiangsu 212018, China)

Feeded one time a day on mulberry leaves, silk worm larvae could develop healthly by adopting some principal measures as following:

1. applying suitable hole-digged plastic films to padding and then covering the rearing bed;
2. using a few stands to support the covering films;
3. enlarging the rearing bed in advance;
4. spraying enough fresh limes before feeding.

This rearing method could not only result high production but also save labours and matters, and could be accepted by numerous peasants.

PREPARATION OF CYCLINDRICAL SURFACE SHAPED COCOON-CYCLINDRICAL TYPE IN RELATION TO SILK YIELDS.

Yunn-Chao Chen, Feng-Kuo Hsieh, Shing-Chuan Huang (Taiwan Apicultural and Sericultural Experiment Station, Mio-Li, Taiwan, China)

Different number (700, 850 and 1000) of mature silkworm larvae were placed on the surfaces of flat hardboard or cylinders in various shapes (tetragon, hexagon, octagon, and decagon) for flat spinning of silk to determine the differences in silk yields for both types. Results showed that the total silk yields were found to be no significant differences in both types when using 700 or 800 larvae, but were significantly different in 1000 larvae groups. In particular, the greatest amount of silk yield was found in octagon shapped cylinder, and thus it is recommended for practical application.

COMPARATIVE STUDIES ON THE STRUCTURAL PROTEINS OF CPVs FROM HELIOTHIS ARMIGERA AND FROM BOMBYX MORI. Min Zhang, Ji-fang Qian, Hong-sheng Lü (Institute of Plant Protection, Chinese Acad. Agr. Sci., Beijing 100094, China) Jia-lu He, Li-min Tao (The Sericultural Research Institure, Chinese Acad. Agr. Sci., Zhenjiang 212018, China)

By SDS-PAGE, at least 5 major peptides with apparent MW of 97.7, 41.2, 39.4, 36.9, 95.1kd and 4 minor peptides in 92.9–75.0kd MW range were detected in HaCPV-peking isolate capsid, whereas BmCPV capsid was consisted of 5 peptides with MW of 110.9, 101.2, 97.7, 71.1 and 33.0kd. A MW of 32.6kd was determined for predominant peptide of HaCPV polyhedrin, and 30.0kd for BmCPV. Four faintly staining minor peptides both for HaCPV and BmCPV polyhedra respectively were also observed. Results of amino acid composition analysis (represented as molar % : Asp 14.31, Thr 6.00, Ser 10.29, Glu 13.26, Gly 18.88, Ala 11.52, Cys 0.80, Val 5.24, Met trace, Ile 3.68, Leu 3.37, Tyr 1.33, Phe 2.02, Lys 2.62, His 1.44, Arg 1.67, Pro 3.58) showed that HaCPV capsid protein was rich in Ser, Gly, Ala content but poor in Arg, Tyr, Leu, Pro, in comparison with that of BmCPV. Molar percentage of Asp 17.89, Leu 15.13, Arg 9.62, Pro 8.10, Cys 1.40 in HaCPV polyhedrin was much more than that respectively in BmCPV, but Glu 7.29, Val 4.93, Tyr 0.86, Phe 1.32, Lys 3.23 was apparently lesser than the later. The content of Thr 2.97, Ser 6.23, Gly 6.66, Ala 4.63, Ile 9.73 in HaCPV polyhedrin was almost the same in BmCPV.

ON THE PATHOGENICITY OF A MICROSPORIDIA ISOLATED FROM MULBERRY LEAF BEETLE TO SILKWORM

Tang Pinfang, Zhao Ping (The Sericultural Research Institute, Sichuan Academy of Agricultural Sciences, Nanchong Sichuan 630700, China)

The spores of the new pathogenic microsporidia, which was isolated by Nanchong Silkworm Egg Production Farm from a Mulbery Leaf Beetle in Nanchong City in 1991, are elliptical and larger than *Nosema bombycis*. mean length4.14μm, breadth 3.07 μm. The Present series of experiments showed that the Microporidia could infected silkworm, but pathogenicity is lower. The Infection rate of 2nd –5th larvae of soikworm eaten away a piece of 6×6cm² mulbeery leaf with the micrsporidia 10^6 spores/ml brush treatment can reach 40–60%, and others with *Nosema bombycis* 10^4 spores/ml 88–94%. The mean Infected rate of larvae hatched by the eggs laid by infected female moths of the microsporidia is 1.79%, and others of *Nosema bombycis* is 94.5%. Antiformin is of better control result for this microspordia.

THE COMPREHENSIVE STUDY OF SILKWORM MEDICINES KEJIANG-1 AND KELUSU. Chui-qin Zhou, Yun-zhi Li, Shu-zhen Li (Shandong Silkworm Breeding Research Institute, Yantai 264002, China)

spraying the 1-2% Kejiang-1 liquid to the silkworm which is inoculted with white muscardine fungus can get the efficiency of over 95%. Spraying the 0.5-1% Kejing-1 liquid to mulberry and making it dry, then feeding with it the 2nd stage newly exuviated silkworm which is inoculated with white muscardine fungus can get the efficiency of over 90% . Feeding silkworm with Kelusu is very helpfull in prevention and curing the diseases of white muscardine, green muscardine and bacterial septicemia. To prevent and cure silkworm diseases with Kejiang-1 and Kelusu has not any deleterious effect either for the silkworm physiologically or for the quality of cocoon. Having been used in 10 provinces in China for 4 years upon 300,000 boxes of silkworm eggs for preventing diseases proved that the average rate of increase of output was 11.4%.

These two kinds of medicines have been checked by the department concerned of the central government and have been approved to mass-produce.

CYTOLOGICAL CHANGES DURING GAMATOGENESIS IN THE UZIFLY, EXORISTA BOMBYCIS, LOUIS (DIPTERIA : TACHINIDAE). H.P. Puttaraju and H.B. Manjunatha, Department of Sericulture, Bangalore University, P.K. Block, Bangalore 560 009, India.

The Indian Uzifly, Exorista bombycis is a serious Tachinid endoparasitoid of Silkworm Bombyx mori (Lepidoptera : Bombycidae). The detailed gematogenesis of the species (2n=12) studied from the gonads of pupal and adult stages reveals the absence of chiasma formation and the submetacentric 'Y' chromosome larger than acrocentric 'X' chromosome during spermatogenesis are characterstic for the species. The spermatid cells are become elliptical shortly after telophase II and fussiform. A group of spermatozoa are observed in the late pupal stage. On the other hand, the egg development during oogenesis passes in 14 successive stages. Endomitosis was initiated at state 1 and completed after four days just before the onset of vitellogenesis. Oocyte increases its size from stage 8 to 12 and chorian formation occur at stage 13 to 14. The development of spermatids, the egg cell and the relationship with their associated structures are described in detail and discussed their usefulness in evolving Genetic Control methods for this economically important pest.

STUDIES ON THE BIONOMICS AND FORECAST OF WILD SILKWORM, BOMBYX MANDARINA LECCH. Er-Tian Huang, Yan-chun Tang (Sericultural Research Institute of Huzhou, 313000, Zhejiang Province, China)

Wild silkworm (Bombyx mandarina Lecch) is one of the main pests of mulberry in the Taihu lake regions. The insect pest occurs three generations per year. The durations of different stages the peak periods of egg laying, hatching and damaging, the sex ratio and the native predators and their impact on the pest population were elucidated for each generation. The control effect of scraping the overwintering eggs was determined.

On the basis of the date colleted during 8 consecutive years, it was found that the periods of occurrence for each of the three generations were relatively stable with regards to the time during the year, when data of seasonal occurrence had been collected for 3-7 years, the forecast could be carried out according to the interval between egg or pupa and damaging stage. This method is both simple and reasonably accurate.

With regard to the control tactics, it is suggested that emphasis is placed on the first generation of the past; insecticides may be used during the intervals between silkworm rearing periods for the control of the second and third generations; etc.

STUDIES ON THE BUPROFEZIN IN CONTROLLING MULBERRY RHOMBUS LEAFHOPPER AND ITS INFLUENCE UPON THE SILKWORM. Yuan-zhang Kuai(The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang, Jiangsu 212018, China)

A new chemical-Buprofezin is a selective pesticide to control Homoptera. This article reported the effect of Buprofezin used in sericulture controlling Rhombus leafhopper (Hishimonus sellatus Uhler and Hishimonoides sellatiformis Ishihara), the vecter of the mulberry dwarf disease.

The nymphs of Rhombus leafhoppers can be controlled by Buprofezin (25% W P, 100-150g/10_a) which is valid for 25 days with notable effect in the period of 20 days. As the duration of nymph of Rhombus leafhopper is only 15-20 days, spraying the pesticide one time every generation can decrease the population and cut off the infectious way of mulberry dwarf disease MLO, so that the mulberry dwarf disease can be controlled.

Buprofezin has high killing effect on Rhombus leafhoppers without harm to mulberry. In the range of effective control concentrations, no harmful effects has been found on the health of the silk worm and the quality of cocoon as well as silk. This chemical belongs to low poisonous insecticide. So Buprofezing is suitable to be used in sericulture to control the Homoptera insects in the mulberry field.

STUDIES ON THE RELATIONSHIP BETWEEN THE NUMBER OF POSTERIOR SILKGLAND CELL AND COCOON SHELL WEIGHT OF THE SILKWORM, BOMBYX MORI. Bo-xiong Zhong, Yu-cheng Wu (Zhejiang Agricultural University, Hangzhou 310029, China)

More than thirty races of silkworm have been used in the study. The results show that the number of posterior silkgland cell, which differs greatly between races and in the same race while little in sex, is 720 to 1000. The cell number in every race presents normal distribution. The cell number of the race which has higher cocoon shell weight is more and vice versa, except for some special races. In particular, the number of posterior silkgland cell of the wild silkworm which has much lower cocoon shell weight reaches 854, the naked pupa reaches 612 as well. It can be concluded that certain relations exist between the cocoon shell weight and the number of posterior silkgland cell as well as other physiological and biochemical reaction ability.

INTROGRESSION OF SHORT INSTAR PERIOD AND FINE SILK SIZE GENES FROM WILD SILKWORM TO DOMESTIC SILKWORM BY OUTCROSSING. Wei-ping Peng, Feng-an Yu(Dept. of Sericulture, Anhui Agric. College, Hefei 230061, China)

Three out-combinations were made with domestic silkworm and wild silkworm from around Hefei. In the offsprings moltinism and cocoon color segregated at F_1, and more complicately at F_2 and BC_1. The mimetism and fly ability were prone to those of wild parent. Cocoon wt, cocoon shell wt and ratio, silk length, size and reelability presented mostly in the order as followed: wild silkworm $<F_1<F_2<BC_1<$domestic silkworm, and no heterosis was found. Wild silkworm deserved valuable characteristics of short instar period and extremely fine silk size and when integrated to outbreeding program, domestic parent should be of superior cocoon and silk quality and breed lines with desired characteristics should be isolated as early as possible and backcrossed with domestic silkworm and selected on the basis of relationship among characters and on recessive characters, by those ways four basic breed lines of practical value were established.

ISOLATION AND APPLICATION OF TRIMOULTING MUTATION LINE WITH SEX-LIMITED CHARACTER FROM SILKWORM, BOMBYX MORI. Xue-hua Shen (The Sericultural Research Institute, Chinese Academy of Agricultural sciences, Jiangsu 212018, China)

From the four-moulting and sex-limited variety "C Su", the author found a sexlimited and trimoulting mutation line. Through 16 generations in 6 years (i. e, from 1986 to 1991), this mutation line, which was named " C Su: ", was proved to be sexlimited and it's trimoulting characteristic was preliminary stable. This trimoulting race gave the cocoon silk size of 1.6-1.9D, cocoon layer ratio of 24-25%, silk length more than 1000m, raw silk percentage of 16%. The trimoulting larva ratio of "C Su " was 98% in summer and 75% in autumn correspondingly. After hybridization of " C SU " With " Chinese-European stable trimoulting hybrid A" and " B ", F1 hybrids were proved to be strong, easy to rear and without four-moulting segregation. F1 hybrids gave silk size, cocoon layer ratio, length of silk, reelable filament length and raw silk percentage of cocoon to be 1.8-2.02D, 22% , 1000-1200m, 14.66-17.93% respectively.

BIOTHERMODYNAMICAL STUDIES FOR DEVELOPMENT OF BASES FOR BOMBYX MORI. L SEED CROP REARING. R.N.Dutta, Chandrashekariah and P.R.Yadav (SSTL, Kodathi, Carmelram Post-560 035, Bangalore, INDIA).

Quality of mulberry leaves govern the feeding behaviour of B. mori. L larvae. Age of larvae determines the size of the strip and its duration in completion of one strip. Generally 3rd to 5th stage bivoltine larvae exhibited that size of the strip was directly proportional to the age and its time period inversely proportional to the age. Taking these considerations to establish a constant (K) for the equation Larval age = K Strip/Time, of the many limiting factors being associated, quality of the leaf is one of them. Physiogenic vitality of the individual larvae and environmental factors are also associated to the constant (K). Greater the portion of the quality of leaf and nearer the established relation higher the chances of crop success. So, for good seed crop performance of bivoltine, where balanced diet is more required, quantity of quality portion of leaf consumed are more responsible for balanced energy to the larvae.

*SUSTAINABLE USE OF MALE SILKMOTHS OF BOMBYX MORI L. IN EGG PRODUCTION. K.P.Chinnaswamy, *Department of Sericulture,UAS, GKVK, Bangalore-65,India), M.Balakrishnan,(Department of Zoology, Kerala University,Trivandrum,Kerala)M.C.Devaiah(*),R.V.Krishna Moorthy, Department of Zoology, UAS, GKVK,Bangalore-65,INDIA.*

Laboratory experiments were conducted to assess the mating competance of Bombyx mori L, Male silkmoths of NB_4D_2, NB_{18} and C-nichi races by crossing them with females of pure Mysore race. A single male moth was allowed to mate for three hours each time with virgin female and with varied resting duration in between two successive matings. Viz. No rest, 30,60,90,120,180,240 and 300 minutes. A single male moth of NB_4D_2, NB_{18} and C.nichi could mate with as many as 16,14 and 11 female moths, respectively. Statistical analysis revealed that the interaction effect of race, resting duration and mating numbers did not influence the desired grainage parameters like total number of eggs, fertile eggs and egg hatching upto six pairings. It is established that the male moths of these three races can be re-used on sustainable basis upto six matings without rest or with resting interval between zero to 300 minutes inbetween successive matings.

STUDIES ON THE BIOCHEMICAL MECHANISM AND PRACTICALITY OF THE LONG PRESERVED EGGS OF SILKWORM, Bombyx mori. Zhu Jiang, Shi-qing Xu, Chang-le Chen, Jin-ping Sun (Suzhou Sericulture College, Suzhou 215151, China)

With eggs of the practical popular variety of silkwory as material, the metabolic changes of carbonhydrate and protein of the eggs in every diapause stage, the relationship between the regulation of enviromental temperature and long preserved eggs and the practical techniques were studied. The result shows: 1) Regulal changes took place in sorbitol and glycogen of eggs in every diapause stage and some electrophoretic bands of yolk protein, with the sorbitol content as biochemical index it can be considered to monitor and decide the stage which the diapause eggs are in. 2) The test of hatching rate(14 days within incubation at 25°C), health of the newly-hatched silkworm, rearing results and resistance to three virus suggested that enviromental temperature regulation in 0°C band is an ideal way to adapt to the physical demands of the eggs in every diapause stage and to preserve eggs for a long time. 3) The cold storage at 5°C after acid-treatment is an effective to measure to activate the diapause eggs fast and evenly and to improve the practical hatchability of the long preserved eggs. With this method, the hatchability(14 days within incubation at 25°C) of the eggs 550 days after oviposition almost reaches to 100%.

A STUDY ON CHINA ' S ANCIENT SERICULTURE BASED ON THE 12 SERICULTURAL EVENTS TABLET IN HUANGCHEI TEMPLE , SICHUAN PROVINCE .

Wanmin, Zhu(Sichuan Provincial Silk Crop. Chengdu 610017, Sichuan, China)Dayan He (Institute of Sericulture, Sichuan Academy of Agri. Sci., China.)

Sichuan Province is one of the ancient sericultural areas in China, also known as the "Kingdom of Sericulture", for its very long history of mulberry planting and silkworm rearing. The present Guangyuan County, situated in the northwest of Sichuan Province, is also one of the well-developed areas of sericulture. During the Emperor Daoguang years of Qin Dynasty, Zhen Fongji, the local governor, devoted much attention to sericulture and actively advised his people to develop agriculture and sericulture, he drew "the Pictures of Twelve Sericultural Events " according to the complete procedure of sericultural activities, then these pictures were carved into stone tablets by Xiaoloushi. Now these tablets are well preserved in sericultured in sericulture pavilion in Huangchei Temple of Guangyuan City, which is the National Key Preserving Unit of Cultural Relics. Even the tablets have a history over 100 years, during which they were weathered and eroded, their beautiful patterns are still clearly visible and true to life. The pictures summarized the complete procedure including moriculture, silkworm rearing, silkworm egg production and reeling, etc, becoming very rare and precious historical relics about China 's sericulture and possissing a certain referential value for researching the development of China 's sericultural history.

A STUDY ON REDUCING DIAPAUSE PUPAE BY CONTROLLING LIGHT IN EGG PERIOD OF OAK SILK WORM. Guangben Ling, Jizeng Chao (Rushan County, Shandong 264002, China)

Chinese Oak Silk Worm has two generations in Rushan County each year, spring worm and autumn worm. Autumn worm comes from spring worm, but diapause spring worm pupae increase to 76% during the development period. In 1990, spring worm eggs were treated and maintained in dark. The result shows that there're only 8.3% diapause pupae. This technique is applied all over the county now.

EFFECTS OF DIFFERENT FEEDS ON ERI-SILKWORMS AND THEIR COCOON SILK CONTENTS. Bin-xing Wei, Jian-hui Liu, Da-she Qu (Guangxi Agricultural College, Nanning 530005, China)

The protein contents of the castor leaves change greatly in different seasons. The protein contents in cassava leaves is more than taht in castor leaves, but the sugar contents in cassave leavas are less than that in castor leaves. Because of silkworm's feeding habits, appetite and digestion, the gross weight of the silkworm feeded on cassava leaves is still less than that of the eri-silkworm feeded on castor leaves. The latter accumulates lots of sugar in it, in the time of chrysalis, the sugar changes into fat which helps propagation. The feeds which have different nutrition contents affect the contents of the cocoon silk, but not significantly.

STUDIES ON PROTEIN CONTENT IN THE GUT OF DIFFERENT LIFE STAGES OF TASAR SILKWORM ANTHERAEA MYLITTA D. (LEPIDOPTERA : SATURNIIDAE)

NIRANJAN Kr.* AND MEHROTRA, P.N.
University Deptt. of Zoology, Ranchi University, Ranchi

Metabolic requirement of nutritional like protein in various tissues of insect are met by their transport via haemolymph content from the alimentary tract. So the content of protein a major nutrient biomolecule have been estimated spectrophotometrically by standard technique under normal condition, in the gutwall tissues of larva, pupa and adult. The protein content exhibited uniform but greater variation right from first larval instar to fifth final instar but lesser variation in content of glycogen in pupal and adult stages.

STUDIES ON CHOLESTEROL CONTENT IN THE GUT OF DIFFERENT IFE STAGES OF TASAR SILKWORM ANTHERAEA MYLITTA D. (LEPIDOPTERA : SATURNIIDAE)

NIRANJAN Kr. AND MEHROTRA, P.N.
University Deptt. of Zoology, Ranchi University, Ranchi

Metabolic requirement of nutritional biomolecule like cholesterol in various tissues of insect are met by their transport via haemolymph content from the alimentary tract. So the content of cholesterol a major nutrient biomolecule have been estimated spectrophotometrically by standar technique under normal condition in the gutwall tissue of larva, pupa and adult. The cholesterol content exhibited uniform and lesser variation in all the life stages larva, pupa and adult of tasar silkworm.

STUDIES ON THE GLYCOGEN CONTENT IN THE GUT OF DIFFERENT LIFE STAGES OF TASAR SILKWORM ANTHERAEA MYLITTA D. (LEPIDOPTERA : SATURNIIDAE)

NIRANJAN Kr* AND MEHROTRA, P.N.
University Deptt. of Zoology, Ranchi University, Ranchi

Metabolic requirement of nutritional biomolecules like glycogen in various tissues of insect are met by their transport via hemolymph ontent from the alimentary tract. So the content of glycogen, a major nutrient viz molecule have been estimated spectrophotometrically in gut wall tissues of larval, pupal and adult stages under normal conditions. The glycogen content exhibited less variation among foregut, mldgut and hindgut regions in first, second and thirc larvas instar, while, greater variations were found in fourth and fifth larval instar. Whereas, pupal and gut regions have shown less variation.

*Now working in Central Tasar Research and Training Institute, Ranchi

INDOOR REARING OF TROPICAL TASAR SILKWORM ANTHERAEA MYLITTA DRURY

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Ranchi 835303, India.

Tropical tasar silkworm Antheraea mylitta Drury is widely distributed in Central India and commercially cultured on the food plants viz. Terminalia arjuna, T. tomentosa and Shorea robusta. In the traditional tasar silkworm rearing practice, the just hatched worms are directly brushed on to the trees, which exposes the larvae to the vagaries of nature and result in poor crop management and low cocoon yield. Therefore, Indoor rearing of tasar silkworm using wooden trays (3'x 2'x 4") was experimented. 1000-2000 worms were brushed in each tray and tasar larvae were provided with chopped leaves twice a day. The rearing was carried under room temperature and humidity. After third moult, the worms were transferred on to the trees. The results indicate improvement in effective rearing rate (53.18%) when the worms were reared under indoor conditions upto third moult as compared to control (37.08%).

Further, the indoor rearing studies indicate that tasar silkworms can be reared in trays under indoor conditions upto cocooning stage, however, the cocoon yield is reduced (3.65%). Phagostimulants viz. sucrose and glucon-C stimulated feeding behaviour in the tasar silkworm by reducing the frequent movement of worms.

PRELIMINARY REPORT ON THE STEREOSCOPIC REARING OF ANTHERAEA YAMAMAI. Shen Xiao-xing, Bian Yuan-sheng, Li. Hua-xiu (The Sericultural Research Institute of Shan dong 264002, China.) Li Yu-xiu (The silk company of Shan dong 250001, China.) Pan Chuan-yong, Dong Guan-ting, Zhao Feng-biao (Fongshan farm of Silkworm Egg Production, Qixia county, shandong 265300, China.)

Three different method were used in rearing Antheraea yamamai indoors, that was sterekoscopic-rearing, china basin-rearing and PVC. box -rearing. That the stereoscopicrearing was the best method through preliminary experiment, for example the age of silkworm was 1.5 -2 days shorter than ever. Larval viability raised 12--13%, yield per g eggs raised 14--17%, the fresh cocoon weight raised 18--31%, and the cocoon shell weight raised 22--25%. The cocoon shape was wall and color was deep. It was obvious that stereoscopic-rearing was a indeal rearing method indoors.

A STUDY ON THE EFFECT OF CONTROLLING PEBRINE DISEASE OF THE TUSSAH SILKWORM WITH HIGH TEMPERATURES TREATMENT AT PUPAE STAGE. Jin-xiang Chu, Xu Tian (Yunyang Sericulture Experimental Station of Henan Province 474676, China.)

Taking the infested pupae obtained from the 5-instar larvae treated with certain amount of pebrinen pathogen(Nosema spp.) as test materials, treated such pupae with 42-44℃ for 9-12 hours in October (for the univoltine variety) or in January (for bivoltine variety). Investigate the rate of infestation of pebrine under microscope. The rate of infestation of the later is 40% (for univoltine one)and 60% (for bivoltione one) less than that of the CK respectively. Using the eggs produced to reproduce, investigation the 3rd-instar larvae's pebrine in festation rates, we found the reduction rate of control is 90% for the univoltine brood; 100% for the bivoltine generations. In addition, high temperature may serve as a screen to choose out the stronger ones and to promote the ability to resist pebrine and unfavorable conditions. The reability to resist pebrine of the larvae in areas treated with certain amount of pebrine products is higher than that of the CK; the total number of cocoon is 5% more than the CK's. Cocoons of different varieties, susceptable period and degree of infestation show variable controlling effects when treated with high temperatures. Such problems should be studied more in the futrue.

THE EFFECT OF ENVIRONMENTAL CONDITIONS ON THE NATURAL SUSCEPTIBILITY OF NUCLEAR POLYHYDROSIS VIRUS (NPV) OF THE CHINESE OAK SILKWORM. Huai-min Zhou, Zuo-quan Yong (Yunyang Sericulture Experiment Station, Henan 474676, China)

In the old rearing region of virus-infested areas, experiments to determine the effect of environmental conditions on the infestation of NPV were carried out. The results show that under several conditions, the Chinese oak silkworm may be infested with NPV more easly, ie. (1) contacting with 27.9℃ and high humidity, or 15℃ and 90% relative humidity for a certain long period at pupal and egg incubation period; (2) lower temperature of 7-8℃ will inhibit the development of the eggs for 15 days of which the embryos have been formed; (3) the spring Chinese oak silkworms which have been kept under natural room temperature (13-19℃) for more than 30 days; (4) at the larval emergence time, the thickness of egg layers are more than 1.5 cm; (5) feeding with young tender oak leaves; (6) feeding on buds of oak cuttings planted along the river bank; (7) 5-instar larvae at " first-feeding stage "treated with shocking high temperature (38℃) for 3 hours. The Chinese oak silkworm, likes the Bombyx mori, the increasing of infestation of diseases in nature are; the unfavorable conditions do effect the physiological processes of each metamorphosis stage, weakening its health and thus increases the susceptibility to APNPV.

THE STRUCTURE OF ANTHERAEA PERNYI FIBROIN GENE: MOTIF AND PREFERENTIAL CODON USAGE. Kenji Yukuhiro, Toshio Kanda and Toshiki Tamura (National Institute of Sericultural and Entomological Science, Tsukuba Ibaraki 305, Japan)

The sequence of a fibroin cDNA from the wild silkworm, Antheraea pernyi, has been determined. This sequence contained a motif with nucleotides corresponding to polyalanine, as expected from the polypeptide sequence. The G+C content of the clone was more than 63%, which is consistent with the high content of alanine and glycine residues in A. pernyi fibroin. However, A+T was markedly rich at the third codon position compared to the first and second positions. When the four fold redundant codon position of alanine was considered, A appeared most frequently (54.5%). Such a strong preference was not seen in the glycine codon position (T:41.2%, A:29.4%). A different preference of codon usage is seen in the Bombyx mori fibroin gene, where T is used more frequently than A in the alanine codon. It is notable that a similar preference of usage to that of A. pernyi can be observed in the alanine codon of a spider dragline silk cDNA, which also contains a motif with a nucleotide sequence corresponding to polyalanine.

STUDIES ON STRUCTURAL POLYPEPTIDES OF NUCLEAR POLYHEAROSIS VIRUS FROM CHINESE OAK SILKWORM (ANTHERAEA PERNYI) AND ITS INFECTION TO INSECT CELLS. Guoxiang Qiu, Ziran Huang, Tianen Xie (South China Agricultural University, Guangzhou 510642, China)

The purity structural polypeptides from the nuclear polyhedrosis virus of Chinese oak silkworm, Antheraea pernyi (ApNPV) was contect in morphology by electron microscopy. Viron have typical ultraviolet absorbance characteric of insect baculiform virus. Only one band in electrophoretic pattern was developed after treatment with EDTA and heat shocking, its MW was 29500±500 dal., Asp. and Glu. were rich in amino acid composition of polypeptide but His. was lower. There were no less than 23 kinds of polypeptides in viron, their MW range were between $1.76\text{-}7.79\times10^{6}$dal., five of them were the mains peptides.

Ovarian cells of A. pernyi pupae were cultured in vitro, a cells gathering centre arised in primary culture and cells grew well then they could become a monolayer and passaged in 1-2 months. ApNPV was also to infect the homologeous cells, the primary ovarian cells were very sensitive. Furthermore, the medium of infect cell culture was infectous to the pupae and other primary cells. ApNPV was not discovered from replication in heterologeous insect cells.

BREEDING OF 2 NEW VARIETIES OF ANTHERAEA PERNYI-YANTA16, 789 AND THE SELECTION AND MATING OF ITS F1 HYBRID. Hongjiang Yang, Xiaoxieng, Shen, Wenxiu Lu, Zhongming Liou, Jingshui Yu, Qinian Lou, Pei-lai and Shouxing Jiang (The Sericultural Research Institute of shandong 254002, China)

A new variety of Antheraea Pernyi-yanta16 wihic is early-ripe and strong is bred out by using cross-breeding method among four chinese tusser varieties: C66, 781, 446 and 785 through 20 generations, and by using three varieties: 2H30 (bred through laser induction) Fang qing and He Nan6 as three element materials. The other new variety-789 which is rich silky is bred out through 23 generations during 1980-1989. Its found that Yanta16 and 789 are a good hybridization combination through raise comparation in the countryside. We find that the silk production of the new variety is higher than that of the check variety and its silk quality is better than that of the check variety. Its cocoon production per Kg eggs is 10.87% higher than the check and its benefit per Kg eggs is 15.94% more than that of check variety.

A DISCUSSION ON THE HYBRID VARIETIES OF THE TUSSAH SILK WORM OF HENAN PROVINCE. Guang-sheng Ren, Zhi-yuan Bao (Yunyang Sericulture Expermental Station, Henan province 474676, China)

Three varieties, "variety-6", "variety-33" and "He-41" which are the most strong general combining ability ones were used to form 2 pairs of stock varieties of hybrids and 4 pairs of the general varieties of Triple-cross variety to test its effect of yield increase. It is shown that the eggs/per female of the hybrid varieties are 3.67% more than that of "variety-33" by the pupal vitality rate is increased by 4.54%; the cocoon rate is increased by 39.27%. The egg-laying quantity/per female of the Triple-cross one is more than that of "variety-33"by 14%; the cocoon rate is increased by 63.75%; the cocoon shell percentage is increased by 16.15%; the raw silk-producing rate is increased by 19%; the length of silk/per cocoon is increased by 26%. Such tussah silkworm is stronger and easy to rear. We consider such type of combination is the best one of hybrid production of the tussah silkworm.

THE BREEDING OF HIGH SILK-PRODUCTIVITY VARIETY NO. 6 OF UNIVOLTINE TUSSAH SILK WORM. Ze-wang Hu, (Yunyang Sericulture Experimental Station, Henan 474676, China)

Taking variety " Xiao-huen" (bivoltine in Liaoning Province), variety "San-Jou" (Univoltine in Henan province) and variety "101" as parents, utilizing hybridation method by means of mixing spermatozoons, we obtained through 11 generations of breeding, the variety No.6. The eggs of this variety are elliptical in shape, pale brown in color. The head of the lst-linstar larvae are reddish-brown, the body are black in color. The 2-5 instar larvae are pale yellow in color; the cocoon is midsized and is milky-red in color; the cocoon shell is thicker and averages 14% by weight as compared with the total cocoon weight, ranking first in China. The length of silk per cocoon is 1150m. Its non-broken filament length of cocoon is 524m, longer than the CK's by 28%. Raw silk percentage is 72.89%, higher than the CK's by 5.81% . The hybridation test shows that when compared with the cocoon shell weight of 10 thousand newly hatched larvae, this variety has very strong both in common and specific combining ability.

THE DISCOVERY OF AND STUDY ON THE DA-BIE-MOUNTAIN SATURNIIDS (ONE KIND OF CHINESE GIANT SILKWORMS). Zuo-yun Zheng, Zhi-zhong Chen (Henan Agriculture and Husbandry Department Henan Province 450003, China)

In 1988, the Da-Bie-Mountain Saturniids were first discovered in Henan Province. This saturniids lived in the warm, temperate regions at 500-1000m above the sea level with an anual preciptation of 1100-1500 mm. and the diurnal variationof temperature is great, such as in Shang County and Xin County of Henan Province, feeding on Quercus forest. The eggs are blackish-brown in color; the lst instar larvae are yellowish-green; the 2nd-instar are greenish; the head of the 3rd-instar larvae turns from reddish-brown to green; the 4-5th-instar larvae's heads and body change into dark green. The 1st-instar larvae emerge from the eggs in the first 10 days of April; spin cocoons in the last 10 days of June; its adults begin to emerge and corpulate in the last 10 days of July. The larval stage lasts 60-65 days; the pupal stage lasts 30-40 days; the egg stage is 250 days. The cocoon is dark green in color, large-sized, its cocoon-shell percentage is 8.5% more or less; the cocoon-shell thickness is thicker. It is a very rare and valuable species of Saturniid. Therefore, the rearing technique, the corpulation and breeding method have been studied. The cocooning rate is 8% , corpulation rate is more than 80%.

#1

CHARACTERISTICS OF "GIANT EGG" MUTANT OF *BOMBYX MORI* AND INDUCTION OF LARGE EGGS BY APPLICATION OF 20-HYDROXYECDYSONE.

Yutaka Kawaguchi, Yutaka Banno, Katsumi Koga, Hiroshi Fujii, Hiroshi Doira (Faculty of Agriculture, Kyushu University, Fukuoka 812, Japan)

The "Giant egg" (*Ge*, 1-14.0) mutant was characterized in detail. The size of *Ge* egg based on measurements of the major and minor axes was larger than that of the normal egg by 1.18 and 1.12 times, respectively. The weight of an egg was 1.44 times heavier in *Ge* than in normal. The eggs produced by a *Ge* female was 33% fewer in number than those produced by a normal female. The *Ge* egg contained 1.53 times more yolk proteins than the normal egg, although with no qualitative differences.

On the other hand, injection of large amounts of 20-hydroxyecdysone into normal female pupae altered egg production. In addition to normal-sized eggs, large eggs were produced, which resembled the *Ge* eggs in size and weight. Yolk proteins in these eggs had almost the same abundance as those in the *Ge* eggs. The enlarged eggs were distributed in an ovaliole not at random but clustered within a definite region.

#2

GENETIC STUDIES ON THE RELATIONSHIP BETWEEN BROWN-SPOTTED CALTROP AND CALTROP-TYPE MULTILUNAR. Zhonghuai Xiang, Cheng Lu, Yihong Shen (Academic Unit of Silkworm Genetics, Southwest Agricultural University, Chongqing 630716, China)

The brown-spotted Caltrop mutation was discovered in the Research Laboratory of Silkworm Genetics, Southwest Agricultural University.

A study with the methods in experimental genetics showed that the gene L^{ca} is dominant over the gene L^{c}, the dominance in the L multiple alleles appeared in the order of $L^{ca} > L^{c} > L > +^{L}$. As in the case for L^{c} L^{c}, L^{ca} L^{ca} is lethal. On the other hand, L^{ca} L^{c} is not lethal. Thus, L^{ca} and L^{c} show complementation in term of gene lethal effect and the L gene group may be regarded as a "pseudoallelic group".

#3

A GENETIC STUDY OF RECESSIVE GREY IN SILKWORM (BOMBYX MORI L.). Zhonghuai Xiang, Cheng Lu (Academic Unit of Silkworm Genetics, Southwest Agricultural University, Chongqing 630716, China)

Recessive grey egg, a new spontaneous mutant of silkworm, has been discovered and studied in the Academic Unit of Silkworm Genetics, Southwest Agricultural Univertsity. The egg is grey white in color with two or three longitudinal channels milky white. Genetically, the mutant is recessive to $+^{gr-r}$. It is the only recessive grey egg hitherto dicovered in silkworm, different from all the other grey eggs: Gr, Gr^{16}, Gr^{B}, Gr^{X-1}, Gr^{X-2}, Gr^{L}, Gr^{Z} and Gr^{K}. It has been, therefore, named recessive grey egg and designated gr-r. An investigation of linkage with the methods used in experimental genetics has shown that gr-r is independent of lem (3), L(4), E^{ca}(6), K (11), Ng(12), ch(13), Bm(17) or Nd (25) in inheritance and is linked to P^{m}(2), that is to say, gr-r is located in the second linkage group. A three-point experiment localized gr-r at 7.5 in the second linkage group, viz. 2-7.5.

#4

A GENETIC STUDY OF ELLIPSOID EGG-2 IN SILKWORM (BOMBYX MORI L). Cheng Lu, Zhonghuai Xiang (Academic Unit of Silkworm Genetics, Southwest Agricultural University, Chongqing 630716, China)

A new spontaneous mutant called "the second ellipsoid egg" has been discovered in the Ng lines maintained in the Research Laboratory of Silkworm Genetics Soouthwest Agricultural University, Chongqing, China. The egg shape of the mutant is long and thin, with a length factor of 48. 82±2. 49 as against 60.93±3.59 for the well-known ellipsoid egg elp: 16-16.1). The mutation gene has been named "ellipsoid egg 2 " and designated elp-2. A genetic analysis indicated that elp-2 is characterized by recessive inheritance. In crosses of ellipsoid egg strains with ellipsoid egg strains, the phenotype of all F s was normal and the F s segregated into two batches in the ratio of 9 normal: 7 ellipsoid, suggestion that elp-2 and elp assorted independently. In other words, elp-2 gene is not associated with the 18th linkage group. Such a presumption was further supported by the results in a cross of elp-2 with ch-2.

#5

STUDIES ON HISTOMORPHOLOGY OF GUT OF PUPA OF TASAR SILKWORM ANTHERAEA MYLITTA D. (LEPIDOPTERA : SATURNIIDAE)

NIRANJAN K. AND MEHROTRA, P.N.
UNIVERSITY DEPTT. OF ZOOLOGY, RANCHI UNIVERSITY, RANCHI

Histomorphology of gut of pupal stage of tasar silkworm Antheraea mylitta D. a semi domesticated wild silkmoth has been investigated histologically by routine eosin-haem technique to observed the metamorphological degenration of the gut and gut wall tissue organisation during larval, pupal transformation and pupal stage. The histological layers have shown the presence of very thin external peritoneum and muscular layer followed by basement membrance which bears the tall columnar cells having apical nucleus covered with chitinous intima, exhibiting cellular degeneration and regeneration activity.

#6

GENETIC ANALYSES ON THE COCOON SHAPE OF SILKWORM, *Bombyx mori*. T. Nakada (Faculty of Agriculture, Hokkaido University, Sapporo 060, Japan)

In domesticated silkworm strains, cocoon shapes are so diversely expressed that I think it may be also helpful to make clear the genetic relationship among the many strains adapted to the different environments around the world by their morphological analyses. For this purpose a trial, computing the synthetic numerical values of cocoon shape characteristics in each strain, was carried out through the multivariate analyses using some variables measured by the newly developed image processing method.

At first, a dendrogram which shows the degree of resemblance as a whole was drawn to point out the similarity of cocoon shapes among strains tested.

Secondly some kind of crossing experiments were carried out among silkworm strains showing different types of cocoon shape. As a result of observation of progeny tests after crossing, it became clear that there are genetic factors related to cocoon shapes on chromosome level using some marker genes. The difference in cocoon shape between female and male was also statistically analysed to find out the sexual characteritics in quantitative inheritance.

#7

CYTOGENETICAL STUDIES ON ERI-SILKWORM (PHILOSAMIA CYNTHIA RICINI)

Fangzhou Song, Zhonghuai Xiang, Shaolan Liu
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Examination of the chromosomes of lepidoptera insects is easily distinguishable, exact and reliable at the diplotene stage of meiosis since the chromosomes take on the long narrow configuration and homologous chromosomes are parallel to each other in arrangement. In this experiment the chromosome number and sex type of eri-silkworms were studied at the diplotene stage. Thirteen pairs of parallel bivalents and one free univalent were observed for females and 14 pairs of bivalents were observed for the males at metaphase I. Thus, the chromosome number for female and male eri-silkworms is thought to be XX-XO (ZZ-ZO), not XX-XY. The univalent noticed at the diplotene stage is presumably the sex (X) chromosome.

It was observed that the univlent of female eri-silkworms at the diplotene stage twists and folds and partially self-pairs, thus forming a variety of "hairpin-like" configuraton. This is the first report of such a phenomenon in lepidoptera as well as in eri-silkworms and may be of importance for the study of the origin and evolution of the sex chromosome.

#8

CYTOGENETICAL STUDIES ON LONG-TAILED GREENISH SILKMOTH (ACTIAS SELENE HUBNER)

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A modified method of air drying mounting was adopted in an experiment from the autum of 1982 to the spring of 1985 to study cytogenetically the chromosomes of a wild silk-producing insect. Actias selene, which is distributed in the district of Chongqing. It was found out that the meiosis of spermatocytes/oocytes started at the beginning of the 5th instar and that metaphase, which is the most suitable stage for chromosome examination and counting, occurred around 3-4 days after cocooning. Examination of a large number of cells revealed that at metaphase I and metaphase II their chromosome number is n=31 and the chromosome shape is granular.

Since the chromosome number of both sexes is the same, it is inferred that the sex type of the insect is XX-XY. In the prophase of meiosis Actias selene showed distinct leptotene, zygotene, pachytene, diplotene and diakinesis. All the chromosomes were arranged according to their relative and absolute lengths and the number, shape and size of their chromosomes, and a tentative chromosome complement pattern for the female was obtained. Such a result is considered to be of importance for the study of the karyotypes of wild silkworms.

#9

ANALYSIS OF FACTORS CONTROLLING HIGH TEMPERATURE TOLERANCE OF THE SILKWORM, *BOMBYX MORI*.

Masao KATO, Takeshi SHIROTA. (National Institute of Sericultural and Entomological Science, Tsukuba Ibaraki 305, Japan)

To analyze factors controlling high temperature tolerance, we examined the growth of two inbred silkworm lines, which were selected to be tolerant or sensitive to high temperature, at high temperature using different artificial diets.

The two lines of silkworms were reared at three different temperatures, 28 C, 33 C and 36 C, and on three different diets. Statistical analysis of the growth rate showed that larvae of high temperature-adapted line grew faster than the sensitive line. When comparing the effect of composition of artificial diets, the diet containing higher amounts of protein gave faster growth even at the high temperatures. From this evidence, we conclude that tolerance of silkworm to high temperature appeared different in the lines and is effected by nutritional conditions.

#10

STUDIES ON SELECTIVE EFFECT OF SOME PRACTICAL CHARACTERS OF SILKWORM BOMBYX MORI,

Jialong Duan (Department of Sericulture, Anhui Agricultural College)

Several strains were used to study the selective effects of resistance to CPV and cocoon characters. As a result of 7-8 generation selection with CPV oral infection, the sound pupa ratio of the strain, Dong34, was 4.2-38.7% higher than that in the control, but, DaZao only increased 1.7-1.8%. Both the sound pupa ratio and the cocoon quality in the interval-gene--ration selection with CPV were superior to those in the suc--cessive-generation resistant selection with CPV. The concen--trations of CPV used in Spring and Autumn could be 10^5, $\frac{1}{2}\times10^5$, $\frac{1}{4}\times10^5$ and 10^4, 10^3, 10^2 respectively. The general performance of cocoons from the resistant selective blocks which were selec--ted for reprodution was almost the same to that from the con--trol blocks. After five generations of mass selection the co--coon weight, cocoon shell weight, cocoon shell ration and laying of each female were increased by 2-3%, 5-33%, 1-8% and 15-32%, depending on differant strains and characters.

#11

HAVING BRED OF THE SILKWORM VARIETIES "[illegible]" "QIU YING" [illegible] IN SUMMER AND AUTUMN AND THEIR HYBRIDS.

He Ji, Yong-hu Jiang, Jie-xin Jiang, Bai Ping (Suzhou Sericulture College, Suzhou 215151, China)

According to the summer and autumn charateristics of the Yangtze River Valley, we employed the breeding methods of hybridization, back cross, line selection, fresh cocoon reeling and directive cultivation of several generations with high temperature and much humidity, chinese silkworm strain "Lu Hua" and Japanese silkworm strain "Qiu Ying" have been bred respectively.

Both of them have the characteristics of high resistance, high yield of silk, excellent quility of cocoon and silk, and easy reproduction etc.

Their F1 hybrids race were many times identified in the laboratory and countryside, they were examined, and approved by the National Silkworm Variety Appraisal Committee. The results showed: the new variety is strong and healthy, union in incubating, molting, exuviating and maturing, high yield of cocoons and silk 22% cocoon shell ratio, 15-16% raw silk ratio of fresh cocoons. This variety has excellent quility of cocoon and silk. It's reelability percentage is 74%, neatness 95 marks, size of filament 2.53 denier and one cocoon filament length more than 1000 metres.

#12

NUTRITIVE EFFECTS OF ASPARAGINE AND GLUTAMINE ON THE SILKWORM, *Bombyx mori*.

Toshio Ito (Kanto Junior College, Ohya-cho, Tatebayashi, Gunma 374, Japan) and Tamio Inokuchi (National Institute of Agro-biological Resources, Tsukuba, Ibaraki 305, Japan)

The domesticated silkworm requires either aspartic or glutamic acid in addition to the usual ten essential amino acids and semi-essential proline for a normal growth (Ito, 1972). In addition, dietary aspartic acid could be replaced by asparagine, while glutamic acid was replaced partly by glutamine, when younger larvae were tested (Arai and Ito, 1977). Further data on the nutritive effects of two amides will be shown here. Nutritive effects were investigated by growth experiment using defined diets as well as by the analysis of free amino acid composition of the hemolymph of larvae reared on the varying diets.

Growth experiment with half-grown larvae confirmed the previous result that asparagine was effective, while the effect of glutamine was not clear-cut.

When the defined diet lacked both aspartic and glutamic acids, free amino acid composition of larval hemolymph underwent a marked change. Three amino acids (glutamine, alanine, and lysine, in this order) were decreased markedly, while six amino acids (histidine, isoleucine, leucine, methionine, ornithine, and valine) increased noticeably. The rates of increase and of decrease in those amino acids were accelerated after further deletion of the non-essential amino acids and proline from the diet of which two acidic amino acids had been deprived.

The normal amino acid pattern was resumed by including either aspartic or glutamic acid or both into the deficient diet. Furthermore, the inclusion of either asparagine or glutamine was also proved to be effective, more or less, for the recovery of the normal amino acid pattern. Analysis of free amino acid pattern is considered to be useful for the estimation of the nutritional value of amino acids and related compounds.

#13

YIELD AND QUALITY OF SILK OBTAINED FROM BOMBYX MORI L.AFTER FEEDING FIRST INSTAR LARVAE ON ARTIFICIAL DIETS OF DIFFERENT PROTEIN CONTENT.Elisaveta Genova,Nikolai Todorov(Institute of Zootechnics and Veterinary medicine,Stara Zagora,Bulgaria)

Silkworm larvae of Super1xHesa2, Hesa2xSuper1 and ShunreixShogetzu were reared on diets at various levels of dietary protein(18,22,26,29%) during 1st instar.The artificial diets contained 35%mulberry leaf powder, 5%cellulose powder,6% succrose, 7,5%agar, 3%Wesson mix, 1,5% soybean oil refined, 1,5%ascorbic acid, 3,5%citric acid,from 16-37%soybean meal in relation to the required protein level.With low protein mixtures the soybean meal is replaced for by potato starch,energy adjusted at a relatively constant value.Second star and following larvae were fed on spring mulberry leaves by the routine method.Our experimental data showed that protein level in artificial diets designed for first instar did not influence significantly the weight and measurements of the cocoons, the length of silk thread, the silk yield and reeling ability of dry cocoons.The former indeces being of similar values, diviation insignificant(p<0,05).

It was obvious that feeding during 1st age had no effect on the development of the silk gland and its function when the feeding in the following age periods was normal.The retarded growth at 1st instar due to feeding of larvae on mixtures of a lower than 22% protein did not affect the function of the silk gland.

#14

EFFECT OF METHOPRENCE ON THE EMBRYONIC DEVELOPMENT OF EGGS OF SILKWORM, Bombyx mori. Shi-qing Xu(Suzhou Sericultural college,Suzhou 215151,China)

Used the micro-injecting method, it was found that theembryonic development of non-diapause eggs of silkworm and activated eggs after acid-treatment were inhibited by methoprence. The valid period of injection was before the stage of labial lobe appearance("Wu"-A),and the period of inhibition was amon stage of "Wu"-A to stage of embryonic reversal. The inhibiting effect within the valid period of injection were alike,and the extended time was about 2 days. The affecting degree of methoprence on different embryonic tissues was different,other more,the hatchability of treated eggs was more than 83%. Hydroxyecdysone could dispel the inhibiting effect of methoprence on the embryonic development,but it was confined to inject hydroxyecdysone after injected methoprence immediately. If the diapause eggs of silkworm were injected with methoprence within 1-72 hr after oviposition (T. 25°C),the diapause of embryoes that the part of treated eggs would be terminated. The percentage of activated eggs were about 6-62%. The effect was like the effect of hydroxyecdysone. If the diapause eggs were injected with hydroxyecdysone after injected methoprence immediately or vice versa,the effect of the hormones on diapause of the eggs would be counteracted partly.

#15

DEVELOPMENT AND UTLIZATION OF SILK-INCREASER "CAN YAN 2" IN *Bombyx mori* L. Jiaji Wan, Zhijun Xi, Yugui Zhao (Institute of Sericulture, Sichuan Academy of Agricultural Sciences. Nanchong, Sichuan 637000, China)

"Can yan 2" are both silk-increaser and egg-increaser. According to the physiological and biochemical test and the atomic tracing assay, it could reinforce the metabalic functoin of silkworm organism, enhance digestibility and absorption rate of leaf-protein, reduce excretional mass, heigten raw silk percentage of leaves, advance synthesis of silk protein and development of sexual organ, in short, the silk-increaser could increases the dietary efficiency and raise the silk production. The product has been utilized on more than 2 million boxes silkworm egg in 20 provinces in P.R. of China. The investigation in 8 provinces showed that the increment of silk-production was about 6% and egg-production 8%. The administration dose of "Can yan 2" is one time every day in the 3rd instar (or 2nd) for rise silk-production (or egg-production).

#16

STUDIES OF THYROID HORMONE ON ITS ACTING ORGANS AND EFFECT ON THE PROTEIN SYNTHESIS OF SOME ORGANS OF THE 5TH INSTAR SILKWORM BOMBYX MORI. Gang Hua, Jian Zhang (Suzhou Sericulture College, Suzhou 215151, Jiangsu, China)

The experiment is performed on silkworm Bombyx mori into which the ^{125}I-T_4 or ^{125}I-T is injected. We observe whether these labelled hormones can combine with the ten kinds of organs of the insect. The result shows that ^{125}I-T_4 and ^{125}I-T_3 can selectively combine with digestive gut, muscle, malpighian tube, middle and posterior silkglands among which the combination rate with posterior silkgland is the highest. In addition, I-T_3 can combine with fat body.

Furthermore, the effect of thyroid hormone (T_4, T_3) on protein synthesis of some organs when the hormone is injected into the 5th instar. The result shows that the hormones can enhance the protein synthesis of hemolymph, posterior silkgland, and fat body, but inhibit that of midgut, in which T_3 has more effective than T_4 Other discoveries of our experiments are the opposite effect to the early response at the 3rd and 4th day after injection T_3 or T_4 and the death of the insects which are treated with the high dosage of T_4. So, the thyroid hormones in certain rangs can regulated the protein synthesis and metabolism of silkworm Bombyx mori. in some organs.

#17

CONTENTS OF VITAMIN B_6 DERIVATIVES IN THE LARVAE OF THE SILKWORM, *Bombyx mori* BY REVERSE-PHASE HPLC. K. Hamano, K. Kohzuma, and H. Suzuki (Department of Biological production, Tokyo University of Agriculture & Technology, Fuchu, Tokyo, 183, Japan)

Six kinds of Vitamin B_6 derivatives are known to occur in living organisms, namely, pyridoxine, pyridoxal and pyridoxamine and their respective phosphates. Contents of the B_6 derivatives in several tissues of silkworm larvae were determined by means of reverse-phase high-performance liquid chromatography. A reverse-phase column (Watersμ-bondasphere, C_{18}), an acidic mobile phase (1% CH_3CN, 1M $NaClO_4$ and 0.1M phosphate buffer pH3.5), and fluorometric detection (Ex. 305 nm, Em. 390nm) were employed. Extraction of the derivatives from larval tissues was done by ultrasonic homogenizer in 0.1N-$HClO_4$. The 5th-instar larvae were allowed to be fed on the chemicaly defined diet containing pyridoxine, and the predominant component of B_6 derivatives was found to be pyridoxal-phasphate in blood and silkgland of the larvae. Small amounts of pyridoxamine-phosphate, pyridoxamine and pyridoxine were also detected.

#18

DETERMINATION OF GLUTAMIC PYRUVIC TRANSAMINASE (GPT) ACTIVITY IN SOME TISSUES OF SILKWORM BOMBYX MORI. Zhang Jian, Hua Gang, Yu-jin Dai(Suzhou Sericulture College,Suzhou 215151,Jiangsu,China)

The experiment has determined the glutamic pyruvic transaminase (GPT) activity in some tissues of silkworm Bombyx mori. The results show that the activity in posterior silkgland is the highest among these tissues, and gets to the maximum at the later peroid of the 5th instar and keeps on high level until the matured larvae. Also, GPT is found in other tissues, except hemolymph, among which GPT activities arehigh but lower than that of posterior silkgland. The GPT activity in midgut, as well as in fat body, has no obvious changes between the 4th and 5th instars, and gets to a lower level in matured larvae. The middle silkgland GPTis much lower at the 3rd day-4th instar and reaches the peak at the 2nd day-5th instar, then reduces gradually, which are different from the changes in posterior silkgland. The muscle GPT activity is relatively lower and there is no obvious changes of it. The analyses further demonstrate the specific activities of GPT are higher in midgut and posterior silkgland. Therefore,GPT locates mainly at the posterior silkgland and the midgut of silkworm, Bombyx mori.

#19

STUDIES ON THE BIOCHEMICAL MECHANISM AND PRACTICALITY OF THE LONG PRESERVED EGGS OF SILKWORM, Bombyx mori .

Zhu Jiang, Shi-qing Xu, Chang-le Chen, Jin-ping Sun (Suzhou Sericulture College, Suzhou 215151, China)

With eggs of the practical popular variety of silkwory as material, the metabolic changes of carbonhydrate and protein of the eggs in every diapause stage, the relationship between the regulation of enviromental temperature and long preserved eggs and the practical techniques were studied. The result shows: 1) Regulal changes took place in sorbitol and glycogen of eggs in every diapause stage and some electrophoretic bands of yolk protein, with the sorbitol content as biochemical index it can be considered to monitor and decide the stage which the diapause eggs are in. 2) The test of hatching rate(14 days within incubation at 25°C), health of the newly-hatched silkworm, rearing results and resistance to three virus suggested that enviromental temperature regulation in 0°C band is an ideal way to adapt to the physical demands of the eggs in every diapause stage and to preserve eggs for a long time. 3) The cold storage at 5°C after acid-treatment is an effective to measure to activate the diapause eggs fast and evenly and to improve the practical hatchability of the long preserved eggs. With this method, the hatchability(14 days within incubation at 25°C) of the eggs 550 days after ovipositi-
on almost reaches to 100%.

#20

ON THE FLIGHT ABILITY OF THE BOMBYX MOTHS.

Wei-de Sen, Yu-ting Hu (Sericulture Department, Suzhou Sericulture College, Suzhou 215151, China), K. Hamano (Department of Biological Production, Tokyo University of Agriculture & Technology, Tokyo, 183, Japan).

The flight ability has been lost in the domestic silkworm in a long process of domestication. Thus, the flight ability of F1 hybrid between Bombyx mori and B. mandarina, which is considered to be an ancestor of B. mori, was investigated.

Results showed that more than 70% of F1 male moths could fly, whereas newly emerged F1 female moths were mostly unable to fly. However, about half of them showed the flight ability after finishing the egg-laying. Significant correlation between the flight activity and the body weight of moth was not recongnized, but the correlation between flight ability and weight of the thorax was found to be significant.

Relative weight between thorax and abdomen of the moth was more important than total body weight in the flight of F1 silkworm moth.

furthermore, the positive correlation between the flight ability and the activity of some specific enzymes, occurring in flight muscles, was observed.

#21

PREPARATION OF CYCLINDRICAL SURFACE SHAPED COCOON-CYCLINDRICAL TYPE IN RELATION TO SILK YIELDS.

Yunn-Chao Chen, Feng-Kuo Hsieh, Shing-Chuan Huang (Taiwan Apicultural and Sericultural Experiment Station, Mio-Li, Taiwan, China)

Different number (700, 850 and 1000) of mature silkworm larvae were placed on the surfaces of flat hardboard or cylinders in various shapes (tetragon, hexagon, octagon, and decagon) for flat spinning of silk to determine the differences in silk yields for both types. Results showed that the total silk yields were found to be no significant differences in both types when using 700 or 800 larvae, but were significantly different in 1000 larvae groups. In particular, the greatest amount of silk yield was found in octagon shapped cylinder, and thus it is recommended for practical application.

#22

MASS REARING CHINESE SILK WORM (BOMBYX MORI) IN THE TUNNEL PUT IN ORDER OF WOODEN FRAMES.

Qishan Wang (The Bureau of Agriculture, Husbandry and Fishery of Anfu County, Jiangxi 343200, China)

The new method of mass rearing Chinese Silk Worm in the tunnel put in order of wooden frames was given by the Institute of Sericulture and Tea of Jiangxi Province. In Anfu County, this new mass rearing method was rapidly propagated and applied, saving costs by 67.3% and increasing incomes by 32.5%. The new rearing method was introduced and extended to Jiangxi, Zhejiang and Anhui Province etc. The author got award by Jiangxi Province.

#23

TECHNOLOGY OF RAISING BREEDING ARTIFICIALLY THE NATURAL ENEMY OF CRYPHALUS EXIGNUS BLAND-CRYPTOLESTES TURCICUS GROUVILLE.

Jun Wang(Institute of sericuiture Hebei Academy of Argieulture and Forestry Seienees ehengde 067000, China)

It was first found that the image and larva of Cryptolestes tureicus Grouville can catch and eat the egg, larva and the pupa's body fluid of Cryphalus exignus Bland and make them dead.

We have studied and mastered the technology of feed preseription, breeding conditions and purifying rejuvenation of the natural enemy. After releasing it for 3 ycars, the death ratc of mulberry bud in several thoussand mu is reduced from 40–50% to 2–4%.

#24

AN INVESTIGATION ON THE EFFECT OF ROOT KNOT PARASITIC NEMATODES (*MELOIDOGYNE INCOGNITA*) ON MULBERRY PLANT (*MORUS* SPP.).

P.K. Ghosh, A.K. Sen, B.K. Das, B.C. Das, A.K. Sahakundu, P.K. Mistri, S.K. Sen, C.K. Kamble , G. Subba Rao (Central silk board, Ministry of Textiles, Govt. of India, National Silkworm Seed Project, Technical Service Centre, Mothabari, P.O. Mothabari, Pin-732207, Dist. Malda, West Bengal, India)

An intensive investigation was carrried out in different villages of Mothabari area, Malda, W.B. , India, during the period 1983-1991 to see the effect of root knot parasitic nematodes(*Meloidogyne incognita*) on Mulberry plants (*Morus* spp.) were reported in this paper. Mulberry plants are widely infected with root knot nematodes. The intensity and frequency of occurrence varies in different localities. The maximum infection were found in the older plants than new plants. A number of yield component growth parameters were recorded like plant helght, leaf/plant, leaf yield/plant, leaf angle, branching angle,shoot yield/plant, plant spread, branching angle, pod, root length, nodules/plant and growth rate etc. were found maximum in the non-infected plants. The object of the present investigation was that to find out their occurrence, intensity and distribution in plants in different areas and also estimate crop loss due to this infection.

#25

THE PRODUCTION OF SUPERFINE COCOON FILAMENTS BY INSECT GROWTH REGULATORS. Xue-fang Lu (Zhejiang Agricultural University, Hangzhou 310029, China)

In 1985, we firstly succeeded in inducing trimoulter with chemicals (SM-1) to produce superfine cocoon filament. Afterwards, new trimoulter inducers (Golden Deer) were developed. When the silkworms are feeded with a proper concerntration of chemicals for a certain time at 3nd or 4th instar, all the silkworms will become trimoulter.

The induction of trimoulter of commercial races can be carried out during every season, and the cocoon filament size can be regulated between 1d and 2d which is 1/3-1/2 finer than that of the tetramoulter. The induced trimoulter shows stronger resistance and has a smaller percentage of disease. The reelability percentage of the induced trimoulter cocoon is remarkably higher than that of the control. The inducing technique for trimoulter has been released and applied in Jiangsu and other provinces during the past six years.

The quality of these kinds of superfine cocoon filaments is excellent. Characteristics such as less size deviation, better evenness, neatness, higher tenacity, elongation, cohesion and other advantages are found. The raw silk reeled in great deal reached 4A to 5A. About 80 tons of fine raw silk (13/15) and about 10 tons of fine silk composite yarn were produced. Many light fabrics such as chiffon and habotai etc. were also woven.

#26

REGULATION OF ECDYSONE ON BIOSYNTHESIS AND ACCUMULATION OF THREE YOLK PROTEINS OF THE SILKWORM, BOMBYX MORI AND INFLUENCE ON OVARY DEVELOPMENT. Xiao-feng Wu, Jun-liang Xu (Zhejiang Agricultural University, Hangzhou 310029, China)

In this test, by treating the ligatured pupae with different doses of ecdysone and carrying a series of quantitative determination with immunoelectrophoresis, regulation of ecdysone on biosynthesis and accumulation of three yolk proteins of the silkworm and influence on ovary development were discussed. Results showed: it could accelerate the speed of development of the posterior eggs after the ligature pupae were treated with different doses of ecdysone, and the most effective dose was about 10 μg per pupa, but highr dose caused pupae dead; the content of Vg, 30 KP in haemolymph and Vtn, 30 Kp, ESP in ovary also increased, the effect was: 10 μg>5 μg >1 μg. Moreover, the relationship between length of the posterior egg and development of ovary, and the factors influencing the co..ent of Vg, 30 KP in haemolymph were discussed.

#27

APPLICATION OF MH IN SERICULTURE AND STUDY ON ITS MECHANISM. Yu-jin Dai, Hua Gang (Suzhou Sericulture Institute, Suzhou 215151, Jiangsu, China)

This paper, based on a series of experiments for years, summerizes the application of phytogenous MH in sericulture and its effect as maturating agent or silk increasing agent under various conditions. And MH acting mechanism is studied on subcellular and molecular level. The results show that the treatment of silkworm larvae with MH at the middle or later peroid of the 5th instar can enhance maturation, cocoon and decrease income when no enough mulberry lerf or silkworms suffer from diseases. In addition, under the good condition, one treatment with moderate MH in the early stage of the 5th instar or continuous treatment with lower dosage everyday in the same instar can raise silk production and the ratio of leaf-silk transformation significantly as the instar peroid may lengthen or shorten a bit. With electron microscope, RIA, and other methods, it becomes clear that the post silkgland cell is one of the MH target cells whose ultra-structure is regulated by MH, and MH plays a positive regulation on protein synthesis, including fibroin, in the post silkgland cells.

#28

CHEMICAL STRUCTURE OF SILK PROTEINS PRODUCED BY THE SILKWORM RAISED ON AN ARTIFICIAL DIET. Takashi YAMAZAKI (Kyoto Univ. of Education, Fujinomori, Kyoto 612, Japan), Hiraku ITO (Saint Agnes' Junior College, Nampeidai, Takatsuki 569, Japan), Masatoshi ICHIDA, Hajime MORI, Fujiyoshi MATSUBARA (Kyoto Institute of Technology, Matsugasaki, Kyoto 606, Japan)

Silkworms (Kinshuu x Shougetsu) were raised on an artificial diet (A) or on a mulberry diet (M) for an entire instar. The artificial diet consisted of a Tofu-cake as its main component. Two types of cocoons (A and M) were used as sample materials. The dissolution behavior of A sericin in hot water was different from that of M sericin. It was found that the amount of A sericin dissolved (28%) was higher than that of M (24%), and the dissolution rate of A sericin was almost twice as much as that of M sericin. The A and M sericins were each separated into 4 fractions according to the dissolution rate in hot water, and the amino acid compositon (AAC) of each fraction was determined. Although the AAC of unfractionated A sericin was almost the same as that of M sericin, the first fraction of A sericin contained a relatively higher amount of serine. The AAC of A and M fibroins were also evaluated and found to be almost identical within experimental error. The X-ray diffraction pattern of A fibroin was also found to be almost the same as that of M fibroin.

#29

THE ROLE OF UBIQUITIN IN POSTERIOR SILK GLAND OF BOMBYX MORI S.Ichimura-Numata, K.Mita, M.Nenoi (Div. of Biology, Nat'l. Inst. of Radiol.Sci., Chiba 260, Japan) M.Numata (Div. of Antibiotics, Nat'l.Inst.of Health of Japan,Tokyo 141,Japan)

Ubiquitin is a highly conserved polypeptide in eukaryote that is involved in many cellular reaction through its covalent attachment to a variety of protein. We were interested in the ubiquitin function during the developmental progress of the posterior silk gland (PSG) of B.mori, which undergoes a hormone regulated cyclical pattern of development with molts and intermolts. During the development of the PSG, fibroin is produced in a highly regulated fashion. At molt stages, transcription of the fibroin gene is minimal while at intermolt stages, especially at 5th instar, the fibroin gene is vastly activated. The Northern blot analysis of PSG RNA showed that two polyubiquitin transcripts are expressed, and the level of each transcript is distinctively regulated during developmental progress. The levels of the transcripts accumulate at molt stages, indicating an inverse correlation of the expression of polyubiquitin and fibroin mRNAs. The ^{35}S-pulse labelling experiment of PSG revealed that at molt stages various proteins other than fibroin are actively synthesized, whereas fibroin is selectively synthesized with concomitant decrease in the levels of other protein syntheses in 5th-instar. The Western-blot analysis of PSG proteins using antibody against ubiqutin showed various proteins are ubiquitinated at molt stages. These results lead to speculate that ubiquitin might mediate selective degradation of the short lived proteins expressed at molt stages.

#30

FINE SURFACE STRUCTURE OF COCOON FILAMENTS OF THE WILD BOMBYCIDAE SILKWORMS. Jun-liang Xu (Sericulture Department, Zhejiang Agricultural University, Hangzhou 310029, China), K. Hamano (Department of Biological production, Tokyo University of Agriculture and technology, Fuchu, Tokyo, 183, Japan), and T. Ito (Kanto Junior College, Tatebayshi, 374, Japan).

Surface structure of cocoon filaments of the wild silkworm, *Bombyx mandarina* and of mulberry white caterpillar, *Rondotia menciana*, were studied by means of scanning electron microscope, and the crystal-like, round, microscopic substances were observed numerously on the cocoon filaments, especially in the latter insect. Inorganic elements of the microscopic substances on *Rondotia* filaments were determined by means of energy dispersive X-ray analysis interfaced to scanning electron microscope. In *Rondotia* filaments, Na, Mg, Si, S, K and Ca were detected as trace elements, buts its microscopic substance were composed mainly with Ca, and Si and S were detected as trace elements.

#31

STUDIES ON A CLONE OF TETRAGONAL POLYHEDRON OF Bombyx mori NUCLEAR POLYHEDROSIS VIRUS AND ITS CHARACTERES.

Chen-liang Gong, Chan-le Chen (Suzhou Sericulture College, Suzhou 215151, China), Keng-ming Lu (Huanan Agriculture University, Guangzhou 510642, China), Mintang Li (UMDNJ-New Jersey Medical School, USA)

By using a plaque technique for culturing silkworm cell in vitro, a Bombyx mori nuclear polyhedrosi virus ($BmNPV_h$) was screened to obtain a representative tetragonal polyhedron clone strain($BmNPV_t$). The results in the present experiment show that the symptomy and cell pathological changes of silkworm infected with the $BmNPV_t$, its occulted stage and the target tissue, and multiplication in the body, and its pathogenicity to the silkworm were no diverse from a nuclear polyhedrosis virus hexagonal polyhedron strain ($BmNPV_h$). It is indicated with the serological reactions that was a common antigen determinant in the both $BmNPV_t$ and $BmNPV_h$ but not among the $BmNPV_t$ and the tetragonal BmCPV(CPV_t), the hexagonal BmCPV(CPV_h), BmDNV and $BmCPV_{SH}$(CPV nuclear embeded strain to be found at Suzhou). The polyhedrin of $BmNPV_t$ was homologous to that of $BmNPV_h$, while the former was vary from the later in the constitutes and stablization to acidic and alkali solution. The digestion pattern for the $BmNPV_t$-DNA revealed that there was a slightly diverse from a Suzhou strain, Zhenjiang strain and Japan strain of BmNPV.

#32

EFFECTS OF GUANIDINE ADMINISTRATION FOR THE CONTROL OF INFECTIOUS FLACHERIE OF THE SILKWORM, BOMBYX MORI.

Shigetoshi Miyajima (Faculty of Engineering, Mie University, Tsu, Mie 514, Japan) & Shigemi Kawase (Faculty of Agriculture, Nagoya University, Nagoya 464, Japan)

Inhibitory effect of guanidine hydrochloride(GH), was investigated on the incidence of the infectious flacherie of the silkworm. The progression of the infectious flacherie caused by IFV inoculation was inhibited markedly when the larvae were fed with aqueous solution of 0.01 % GH or several other guanidine salts immediately after or before the IFV inoculation. Several salts of guanidine and derivaties were tested for their inhibitory effects on the disease. Of these chemicals, guanidine carbonate, g.nitrate, g.phosphate, g.sulfamate reduced the incidence of infectious flacherie in the same way as GH did. On the other hand, sulfaguanidine, which does not dissociate into guanidine radicals, fails to reduce it. From these results, it is suggested that the antiviral activity of several guanidine salts, on the infectious flacherie virus is associated with guanidine radical. Several properties of the cocoon and raw silk produced by the larvae reared on artificial diet or mulberry leaves to which GH had been added to control the incidence of flacherie, investigated. No difference in the properties of the cocoon and raw silk, including the length and weight of the cocoon filament, raw silk percentage, reelability percentage were observed between control and GH-treated larvae.

#33

THE INACTIVATION OF NUCLEAR-POLYHEDROSIS VIRUS (NPV) AND CYTOPLASMIC-POLYHEDROSIS VIRUS (CPV) OF SILKWORM WITH CALCIUM HYDROXIDE SOLUTION.

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Soaking NPV and CPV in the saturated solution (0.043N) of calcium hydroxide for 5 minutes, we can see under the electronic microscope that all the NPV and CPV are also dissolved and inactivated. Centrifugalizing the density gradient of the solution also proves that the nucleocapsid is dissolved.

Treating NPV for 5 minutes with the solution of natrium hydroxide and calcium hydroxide (0.043N) separately, and then feeding the newly hatched larvae with the solution which was used, we could observe that the ratio of getting disease in the natrium hydroxide area was 51.6%, and none in the calcium hydroxide area. This proved that the inactivation of NPV and CPV by the treatment with calcium hydroxide was not noly for the dissolution of basicity hydroxide ion to virus protein and nuclein, calcium ion played its own role, too.

#34

STUDIES ON SEROLOGY OF THE PATHOGENIC FUNGI OF THE SILKWORM, BOMBYX MORI L.

Liangen Shi (Zhejiang Agricultural University, Hangzhou 310029, China)

The serological basic properties and difference of the pathogenic Beauveria bassiana (White types and yellow types) of the silkworm, Bombyx mori were analyzed by agglutination tests and reciprocal absorption tests in this study. The conidia and blastospores of the two types (white and yellow) of B. bassiana were purified respectively by differential centrifugation. Babbite were immunised with the HCHO-Killed conidia or blantospores by intravenous injectons to make the specific antiserum. The conidia and blastospores of the B. bassiana (white and yellow) had good antigenic, but the antigenic of the blastospores was better than the antigenic of the conidia, agglutinin titer of anti-blastospores serum against blastospores were 50-100 times higher than agglutinin titer of anti-conidia serum against conidia. Blastospores of the two types of B. bassiana and their antiser were used for the reciprocal agglutination tests and reciprocan absorption tests, crossreactions and specific reactions were observed between the two types (white and yellow) of B. bassiana of the silkworm in classification, but also would have the most effect on resources investigation and strain classification of the pathogenic fungi of the silkworm, B. mori.

#35

STUDY ON PATHOGENICITY AND TRANSOVARIAL TRANSMISSION OF *Nosema* sp－SCM_6 IN THE SILKWORM, *Bombyx mori*

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Ming－jun Ao, Biao Yang (Sichuan Silkworm－eggs production Company, China)

The pathogenicity and transovarial transmission of *Nosema* sp－SCM_6 in the silkworm was investigated in the present study. Many of the silkworms died in 5th instar and in the cocooning or pupae stage by peroral inoculation of $10^3－10^5$ spores /individual to mewly molted 2nd larvae. Peroral inoculated of 5×10^5 spores / individual to newly molted 5th larvae, all of the moths were infected. The examination of eggs from the infected female moths showed that *Nosema* sp.－SCM_6 could be transimitted transovarilly. Thirt－nine egg batches obtained *Nosema* sp－SCM_6 spores among 70 egg batches from infected female moths. By examining the larvae of 10 egg batches, the silkworms had transmission rate of $4.85\pm3.44\%$ until the end of the 2nd instar. *Nosema* sp－SCM_6 is smaller than *Nosema bombycis* in the pathogenicity and transovarial transmisson to the silkworms.

#36

NOSEMA SP. -A NEW PATHOGENIC MICROSPORIDIA ISOLATED FROM THE SILKWORM BOMBYX MORI L.

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Ming-Jun Ao, Biao Yang (Sichuan Silkworm-eggs Production Company, China)

A new, pathogenic microsporidian was isolated from Larvae of silkworm-eggs production farm in Sichunn Langzhong in the antumn of 1990. The microsporidia was highly parasitic to the silkworm and invaded into silkglands, Malpighian tubes, muscles, fat bodies and midgut of the larvae. The fresh spores were oval in shape. With a size of 3. 8-4. 1×2.4-2.6 μm. The mean polar filament length was 126 ± 8.35 μm (113-140μm). The sporont (7-9×3-4 μm) dividing into two sporoblasts (4-5×3-4 μm) in the sporulation stages. Ultrastructure studies showed that the polar filament was normally arranged in 14-15coils (sometimes 16) at an inclination of over 40° to the axie Spores. The microsporidia was found to be distinct from Nosema bombycis in the biology and pathology. It is a new pathogenic microsporidin in the silkworm that is named Nosema sp. (SCM_6).

#37

SEQUENCE ANALYSIS OF THE POLYHEDRIN GENE OF A BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS. I. POLYHEDRIN MORPHOLOGY MUTANT AND CONSTRUCTION IN AN UNIVERSAL EXPRESSIBLE VECTOR. Rui-yin Chu, Qin-hua Wang, Yu-lian Lin, Nai-sui Pan and Zhang-liang Chen (National Laboratory of Protein Engineering and Plant Genetic Engineering, Department of Biology, Peking University, Beijing 100871, China)

A morphological mutant with cubic pllyhedra had been isolated from wild BmNPV by plaque purification technique. The virus DNA was digested with EcoRI and cloned into bluescript. Five clones containing polyhedrin gene were selected. The inserted 10.6Kb EcoRI fragment was mapped and an additional Xho I site was found upstream to the polyhedrin gene. The polyhedrin gene has been sequenced entirely together with some 5' and 3' flanking sequences. Comparison of the nucleotide sequence with BmNPV T3 isolate revealed that a single point mutation occurred within the polyhedrin coding sequence. This point mutation caused a substitution of valine by methionine at amino acid 156. The valine at amino acid 156 was also found in another BmNPV isolate and AcNPV E2 strain which appeared normal polyhedra. These results showed that the morphological change of polyhedra was not caused by a single amino acid replacement. Some other factor may be responsible for polyhedrin protein accumulation and involved in the polyhedrin morphological mutation.

By suing PCR mutagenesis technique, a new transfer vector has been constructed with the 10. 6 Kb EcoRI fragment. A Hind Ⅲ site was introduced in place of the start coden ATG(ATG→AAGCTT).

#38

EXPRESSION OF TRICHOSANTHIN IN SILKWORM LARVAE INFECTED WITH A RECOMBINANT BACULOVIRUS, BOMBYX MORI NUCLEAR POLYHEDROSIS VIRUS. Rui-yin Chu, Yu-lian Lin, Nai-sui Pan and Zhang-liang chen (National Laboratory of Protein Engineering and Plant Genetic Engineering, Department of Biology, Peking University, Beijing, 100871, China)

Trichosanthin is a 26-kDa plant-drived ribosome-inactivating protein with potent inhibitory activity against human immunodeficiency virus (HIV) in vitro. The trichosanthin gene had been cloned from the genomic DNA of Trichosanthes kirilowii Maximowich by PCR amplification. The amplified DNA fragment encoding for a protein with 270 ammino acids including a putative signal peptide of 23 aa had been inserted into a new BmNPV transfer vector. Bm-N cells were co-transfected with the recombinant transfer vector and the authentic BmNPV DNA. Through homogeneous sequences recombination in the cell, a recombinant virus harboring trichosanthin gene had been selected and purified by plaque assay. Silkworm larvae infected with the recombinant virus on the first day of the fifth instar produced significant amounts of trichosanthin protein, five days after infection. The recombinant trichosanthin synthesized in the hemolymph was analyzed by SDS-PAGE and detected by western blotter using a rabbit anti-trichosanthin antiserum. It is interesting that silkworm infected with recombinant virus showed delaying of disease symptom development comparied with wild BmNPV. This may be due to the antiviral activity of the expressed trichosanthin. The work of studying the structure-function relationship of trichosanthin and improving its value in application using baculovirus expression system is in progress.

#39

EXPRESSION OF THE HUMAN α-INTERFERON GENE IN SILKWORM BOMBYX MORI BM-5 CELL. Chan-le Chen, Chen-liang Kong: (Suzhou Sericulture College, Suzhou 215151, China), Zhan-yi, Xiang-fu Wu: (Shanghai Institute of Biochemistry, Academia Sinica, Shanghai 200031, China)

Human α-interferon gene was expressed in silkworm Bm-5 cell using insect baculovirus from Bombyx mori nuclear polyhedrosis virus (BmNPV) as expression vector. The α-interferon gene have been inserted into the vector pBE284 to constitute a transfer plasmid pBEIFN-α that inovolved the human α-interferon gene under the control of BmNPV polyhedrin gene promoter. A high-expression recombinant virus was obtained by using the Bm-5 cell cotransfected with the pBEIFN-α-DNA and BmNPV-DNA.

#40

THE DISCOVERY OF AND STUDY ON THE DA-BIE-MOUNTAIN SATURNIIDS (ONE KIND OF CHINESE GIANT SILKWORMS). Zuo-yun Zheng, Zhi-zhong Chen (Henan Agriculture and Husbandry Department Henan Province 450003, China)

In 1988, the Da-Bie-Mountain Saturniids were first discovered in Henan Province. This saturniids lived in the warm, temperate regions at 500-1000m above the sea level with an anual preciptation of 1100-1500 mm and the diurnal variationof temperature is great, such as in Shang County and Xin County of Henan Province, feeding on Quercus forest. The eggs are blackish-brown in color; the 1st instar larvae are yellowish-green; the 2nd-instar are greenish; the head of the 3rd-instar larvae turns from reddish-brown to green; the 4-5th-instar larvae's heads and body change into dark green. The 1st-instar larvae emerge from the eggs in the first 10 days of April; spin cocoons in the last 10 days of June; its adults begin to emerge and corpulate in the last 10 days of July. The larval stage lasts 60-65 days; the pupal stage lasts 30-40 days; the egg stage is 250 days. The cocoon is dark green in color, large-sized, its cocoon-shell percentage is 8.5% more or less; the cocoon-shell thickness is thicker. It is a very rare and valuable species of Saturniid. Therefore, the rearing technique, the corpulation and breeding method have been studied. The cocooning rate is 8%, corpulation rate is more than 80%.

#41

EFFECT OF THE WEIGHT OF PUPA AND MOTH ON EGG OF CHINESE OAK SILK WORM. Shiquan Wang (Silk Worm Station of Zhuanghe County, Liaoning 116400, China)

The author carried out the experiments of effect of the weight of pupa and moth on eggs of Chinese Oak silk worm (variety named " Qingliu hao"). The egg is positively related to the weight of pupa and moth. The author discussed the significance of the results in the production of silk morm.

#42

THE BREEDING OF HIGH SILK-PRODUCTIVITY VARIETY NO. 6 OF UNIVOLTINE TUSSAH SILK WORM. Ze-wang Hu, (Yunyang Sericulture Experimental Station, Henan 474676, China)

Taking variety " Xiao-huen" (bivoltine in Liaoning Prcvince), variety "San-Jou" (Univoltine in Henan province) and variety "101" as parents, utilizing hybridation method by means of mixing spermatozoons, we obtained through 11 generations of breeding, the variety No.6. The eggs of this variety are elliptical in shape, pale brown in color. The head of the 1st-linstar larvae are reddish-brown, the body are black in color. The 2-5 instar larvae are pale yellow in color; the cocoon is midsized and is milky-red in color; the cocoon shell is thicker and averages 14% by weight as compared with the total cocoon weight, ranking first in China. The length of silk per cocoon is 1150m. Its non-broken filament length of cocoon is 524m, longer than the CK's by 28%. Raw silk percentage is 72.89%, higher than the CK's by 5.81% . The hybridation test shows that when compared with the cocoon shell weight of 10 thousand newly hatched larvae, this variety has very strong both in common and specific combining ability.

#43
A DISCUSSION ON THE HYBRID VARIETIES OF THE TUSSAH SILK WORM OF HENAN PROVINCE. Guang-sheng Ren, Zhi-yuan Bao (Yunyang Sericulture Experimental Station, Henan province 474676, China)

Three varieties, "variety-6", "variety-33" and "He-41" which are the most strong general combining ability ones were used to form 2 pairs of stock varieties of hybrids and 4 pairs of the general varieties of Triple-cross variety to test its effect of yield increase. It is shown that the eggs/per female of the hybrid varieties are 3.67% more than that of "variety-33" by the pupal vitality rate is increased by 4.54%; the cocoon rate is increased by 39.27%. The egg-laying quantity/per female of the Triple-cross one is more than that of "variety-33"by 14%; the cocoon rate is increased by 63.75%; the cocoon shell percentage is increased by 16.15%; the raw silk-producing rate is increased by 19%; the length of silk/per cocoon is increased by 26%. Such tussah silkworm is stronger and easy to rear. We consider such type of combination is the best one of hybrid production of the tussah silkworm.

#44
BREEDING OF ANTHERAEA PERNYI HYBRID NO.6. Yonggao Li (Haicheng City Forestry Bureau, Haicheng City, Liaoning 114200, China)

Antheraea pernyi hybrid No.6 is the hybrid strain which tusser Race Qing × Race Xinghuang & Reaction The colour of the larva is yellow, the shape of the cocoon is big, the number of F1 hybrid's eggs are more than the number of CK. The development duration of larva is reduced 1-3 days. It can fight drought & high temperature and rough fodder-resistant. It has high yield property and the cocoon quality is good. It's cocoon weight of thousand is over 0.52 kg than Ck. It applied to produce in the South &West part of Liaoning Province.

#45
BREEDING OF 2 NEW VARIETIES OF ANTHERAEA PERNYI-YANTA16, 789 AND THE SELECTION AND MATING OF ITS F1 HYBRID. Hongjiang Yang, Xiaoxieng, Shen, Wenxiu Lu, Zhongming Liou, Jingshui Yu, Qinian Lou, Pei-tai and Shouxing Jiang (The Sericultural Research Institute of shandong 254002, China)

A new variety of Antheraea Pernyi-yanta16 wihic is early-ripe and strong is bred out by using cross-breeding method among four chinese tusser varieties: C66, 781,446 and 785 through 20 generations, and by using three varieties: 2H30 (bred through laser induction) Fang qing and He Nan6 as three element materials. The other new variety-789 which is rich silky is bred out through 23 generations during 1980-1989. Its found that Yanta16 and 789 are a good hybridization combination through raise comparation in the countryside. We find that the silk production of the new variety is higher than that of the check variety and its silk quality is better than that of the check variety. Its cocoon production per Kg eggs is 10.87% higher than the check and its benefit per Kg eggs is 15.94% more than that of check variety.

#46
INTEGRATED TECHNIQUE OF CHINESE OAK SILK WORM WITH HIGH AND STABLE YIELD IN FRIGID ZONE. Chengjun Hu, Yingqiong Chen (Silk Worm Station of Jixi City, Heilongjiang Province 158100, China)

Since 1986, the experiments on the integrated techniques arising the yield of oak silk worm in frigid zone have been carried out for six years. The high yield and profit were obtained. The author discussed the techniques in this paper.

#47
ON THE REARING TECHNIQUES FOR THE JAPANESE OAK SILKWORM, ANTHERAEA YAMAMAI IN EAST CHINA. Cui Hu, Gong-yin Ye and Xiao-jin Wu (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

Different rearing seasons, rearing fodder plants and rearing methods in East China for the Japanese oak silkworm, Antheraea yamamai were systematically compared from 1988 to 1991. The results indicated that: the best beginning period in East China for rearing the oak silkworm was the 1st or 2nd ten day of April, Quercus fabri as the fodder was better than Q. acutissima. From the 1st to 2nd instar, several or more larvae could be gregariously reared in a container so as to take less man-power. In addition, several meridic diets containing the leaf flour of Q. fabri as leaf factor were acquired through twice orthogonal selecting experiments.

#48
A STUDY ON REDUCING DIAPAUSE PUPAE BY CONTROLLING LIGHT IN EGG PERIOD OF OAK SILK WORM. Guangben Ling, Jizeng Chao (Rushan County, Shandong 264002, China)

Chinese Oak Silk Worm has two generations in Rushan County each year, spring worm and autumn worm. Autumn worm comes from spring worm, but diapause spring worm pupae increase to 76% during the development period. In 1990, spring worm eggs were treated and maintained in dark. The result shows that there're only 8.3% diapause pupae. This technique is applied all over the county now.

#49

A STUDY ON THE EFFECT OF CONTROLLING PEBRINE DISEASE OF THE TUSSAH SILKWORM WITH HIGH TEMPERATURES TREATMENT AT PUPAE STAGE. Jin-xiang Chu, Xu Tian (Yunyang Sericulture Experimental Station of Henan Province 474676, China.)

Taking the infested pupae obtained from the 5-instar larvae treated with certain amount of pebrinen pathogen(Nosema spp.) as test materials, treated such pupae with 42-44℃ for 9-12 hours in October (for the univoltine variety) or in January (for bivoltine variety). Investigate the rate of infestation of pebrine under microscope. The rate of infestation of the later is 40% (for univoltine one)and 60% (for bivoltione one) less than that of the CK respectively. Using the eggs produced to reproduce, investigation the 3rd-instar larvae's pebrine in festation rates, we found the reduction rate of control is 90% for the univoltine brood; 100% for the bivoltine generations. In addition, high temperature may serve as a screen to choose out the stronger ones and to promote the ability to resist pebrine and unfavorable conditions. The reability to resist pebrine of the larvae in areas treated with certain amount of pebrine products is higher than that of the CK; the total number of cocoon is 5% more than the CK's. Cocoons of different varieties, susceptable period and degree of infestation show variable controlling effects when treated with high temperatures. Such problems should be studied more in the futrue.

#50

STUDIES ON STRUCTURAL POLYPEPTIDES OF NUCLEAR POLYHEAROSIS VIRUS FROM CHINESE OAK SILKWORM (ANTHERAEA PERNYI) AND ITS INFECTION TO INSECT CELLS. Guoxiang Qiu, Ziran Huang, Tianen Xie (South China Agricultural University, Guangzhou 510642, China)

The purity structural polypeptides from the nuclear polyhedrosis virus of Chinese oak silkworm, Antheraea pernyi (ApNPV) was contect in morphology by electron microscopy. Viron have typical ultraviolet absorbance characteric of insect baculiform virus. Only one band in electrophoretic pattern was developed after treatment with EDTA and heat shocking, its MW was 29500±500 dal., Asp. and Glu. were rich in amino acid composition of polypeptide but His. was lower. There were no less than 23 kinds of polypeptides in viron, their MW range were between $1.76-7.79\times10^4$dal., five of them were the mains peptides.

Ovarian cells of A. pernyi pupae were cultured in vitro, a cells gathering centre arised in primary culture and cells grew well then they could become a monolayer and passaged in 1-2 months. ApNPV was also to infect the homologeous cells, the primary ovarian cells were very sensitive. Furthermore, the medium of infect cell culture was infectous to the pupae and other primary cells. ApNPV was not discovered from replication in heterologeous insect cells.

#51

THE EFFECT OF ENVIRONMENTAL CONDITIONS ON THE NATURAL SUSCEPTIBILITY OF NUCLEAR POLYHYDROSIS VIRUS (NPV) OF THE CHINESE OAK SILKWORM. Huai-min Zhou, Zuo-quan Yong (Yunyang Sericulture Experiment Station, Henan 474676, China)

In the old rearing region of virus-infested areas, experiments to determine the effect of environmental conditions on the infestation of NPV were carried out. The results show that under several conditions, the Chinese oak silkworm may be infested with NPV more easly, ie. (1) contacting with 27.9℃ and high humidity, or 15℃ and 90% relative humidity for a certain long period at pupal and egg incubation period; (2) lower temperature of 7-8℃ will inhibit the development of the eggs for 15 days of which the embryos have been formed; (3) the spring Chinese oak silkworms which have been kept under natural room temperature (13-19℃) for more than 30 days; (4) at the larval emergence time, the thickness of egg layers are more than 1.5 cm; (5) feeding with young tender oak leaves; (6) feeding on buds of oak cuttings planted along the river bank; (7) 5-instar larvae at " first-feeding stage "treated with shocking high temperature (38℃) for 3 hours. The Chinese oak silkworm, likes the Bombyx mori, the increasing of infestation of diseases in nature are: the unfavorable conditions do effect the physiological processes of each metamorphosis stage, weakening its health and thus increases the susceptibility to APNPV.

#52

PRELIMINARY REPORT ON THE STEREOSCOPIC REARING OF ANTHERAEA YAMAMAI. Shen Xiao-xing, Bian Yuan-sheng, Li. Hua-xiu (The Sericultural Research Institute of Shan dong 264002, China.) Li Yu-xiu (The silk company of Shan dong 250001, China.) Pan Chuan-yong, Dong Guan-ting, Zhao Feng-biao (Fongshan farm of Silkworm Egg Production, Qixia county, shandong 265300, China)

Three different method were used in rearing Antheraea yamamai indoors, that was sterekoscopic-rearing, china basin-rearing and PVC. box -rearing. That the stereoscopicrearing was the best method through preliminary experiment, for example the age of silkworm was 1.5 -2 days shorter than ever. Larval viability raised 12--13%, yield per g eggs raised 14--17%, the fresh cocoon weight raised 18--31%, and the cocoon shell weight raised 22--25%. The cocoon shape was wall and color was deep. It was obvious that stereoscopic-rearing was a indeal rearing method indoors.

#53

A STUDY ON THE TECHNIQUE OF REPRODUCING NUCLEAR POLYHEDROSIS VIRUSES (NPV) WITH PUPAE OF THE CHINESE OAK SILKWORM. Bing-quan Xie, huai-min Zhou, Wan-liang Tao (Sericulture Station of Henan Province, Yunyang County 474650, China)

NPV of Chinese oak silkworm's pupae may be taken as gene bearer in the biological engineering. When planting in human's or other animal's certain genes, it can be utilized to produce precious protein products. This paper deals with the reproduce of NPV of the Chinese oak silkworm. The dormancy period of the Chinese oak silkworm is longer (9 months) , and can be used to reproduce NPV. The authors have studied (1) the period of producing NPV with the pupae of the Chinese oak silkworm, (2) the effect of nurcery process and viro-pupae protection-free treatment, (3) the effect of high temperature on APNPV, (4) the effect of time of the diseased pupae having been kept of the infestation power of NPV, (5) the method of identification of healthy pupae and its selection techniques, (6) the investigation of the NPV reproducing quantity of the diseased larvae and pupae. The virus producing quantity per 100g of diseased larvae is 0.796 g; and that of the diseased pupae is 1.043 g.

#54

THE DAMAGE OF GRANULOSIS VIRUSES (GV) OF CHINESE OAK SILKWORM ON ITS STOCK-PRODUCTION AND SOME SUGGESTIONS OF CONTROL FOR THIS DISEASE. Zuo-yun Zheng, Bing-quan Xie (Sericulture Station of Henan Province, Yunyang County 474650, China)

This paper deals with the effect of granulosis viruses (GV) on the mass-production of Chinese oak silkworm and point out the causes of infection. Some suggestions of control are given. The percentage of infection of GV is 3.05-7.12%. The causes of infection are: some females at egg-laying stage have not been investigated, resulting in a mixed brood of healthy and diseased ones; lacking of strict sanitation measurement; the equipment is too simple and insufficient; unsatisfactory selection of healthy individuals during the larval stage; lacking of a good responsible working system. Recommendations of control; keeping strict microscopic investigation; to practise complete measurements of sanitation; watching strictly the investigation of late cocoon-making larvae; establishing viruefree rearing plots; making good selection at the cocooning laboratory and protect the stock-cocoons well; strengthening the technical education to improve the worker's quality doing their jobs.

#55
SILK PROCESSING OF SEVERAL WILD SILKWORMS IN TAIWAN. Yang-Shan Lin, Tzeng-Cherng Liou, Cheng-Lin Liu, and Yun-Tsong Liou (Taiwan Apicultural and Sericultural Experiment Station, Miaoli, Taiwan, China)

Tussah, camphor and mulberry silk yarns which were degummed by soap-sodium degumming after hydrochloric acid treatment and were dyed with the C.I. acid blue 40. There were large differences in the lightness of the dyed samples. In particular, the chroma of wild silks were lower than that of mulberry silk.

#56
PHOTOACOUSTIC SPECTROSCOPY STUDY AND APPLY FOR THE REMAINDER OF PESTICIDE IN SILKWORM, BOMBYX MORI L. Kun-Rong Jiang, Chan-Le Chen (Suzhou Sericulturs College, Suzhou 215151, China)

Mainly based upon photoacoustic effect, principle of the photoacoustic and spectroscopic technology has been related simply. According to experimental result, study of pesticide for the conversion, distribution and the remainder of pesticide qualitative and quantity determination in the body of silworm, Bombyx mori L, has been reported.

#57
STUDIES ON HISTOMORPHOLOGY OF MIDGUT OF LARVA OF TASAR SILKWORM ANTHERAEA MYLITTA D. (LEPIDOPTERA : SATURNIIDAE)

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Histomorphology of midgut in larva of tasar silkworm A. mylitta D. has been investigated histologically to observe the gut wall tissue organisation and histophysiological events of epithelial regeneration, secretion and absorption. The histological layers of gut wall are external peritoneum followed by circular muscle layer and longitudinal muscle layer. The basement membrane is extensively folded to bear wavy villi consisting of columnar cells, goblet cells and (interestitial) regenerative cells. The luminal folds are organised as villi form ridges interdigitated as fingers, clustars of regenerative cells called nidii are distinctly observed. Luminal tips undego mass breakdown and budding off for secretion purpose. Peritrophic membrane is very distinct mid gut lining the luminal margin of intestinal villi enclosing gut content. Histophysiological contents events of regenerative events, secretion events and absorption events have been disticnly observed.

#58
GENETIC ANALYSIS OF COCOON SHAPE IN SILKWORM (BOMBYX MORI L.). Cheng Lu, Zhonghuai Xiang (Academic Unit of Silkworm Genetics, Southwest Agricultural University, Chongqing 630716, China)

" Length factor", i. e. (width/length of the cocoon) ×100, was adopted as an index for grouping silkworm cocoon shape. In an experiment in which typical oval-shaped cocoon strains were crossed with typical ball-shaped cocoon strains, the inheritance patterns and genetic effects of cocoon shape were investigated. The inheritance of cocoon shape was shown to follow a multigenic pattern, oval cocoon being incompletely dominant over ball-shaped cocoon. Additive gene effects, environmental effects and dominance gene effects accounted for 80%, 15% and 5% respectively, of the overall influence on cocoon shape. The narrow-sense heritability of cocoon shape was estimated to be 71. 08% and its vogorous rate about 10%.

#59
INDUCTION OF RNA COMPONENTS IN THE POSTERIOR SILKGLAND OF BOMBYX MORI BY "KANG-20" TREATMENT. Hao Lin, Danzhen Chen (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China), Dahuan Zhuang, Guohu Chen (The Sericultural Research Institute, Chinese Acad. Agr. Sci., Zhenjiang, 212018, China)

"Kang-20", an imidazole derivative, has been determined as an effective inducer of the precocious metamorphosis in the silkworm, Bombyx mori. After continous feeding the mulberry leaf treated with this compound in the first 48 hrs of the 4th instar larvae the contents of mRNA, rRNA and tRNA increased rapidly and reached maximum on day 5, which were about eight times more than those of the 4th instar control larvae and one third of those in the 5th instar control larvae when their contents was in the highest. The differences in the contents of RNA components between both groups treated with and without "Kang-20" treatment were in a good agreement with those in the cocoon shell weight. Our results suggest that the transcription and translation of fibroin gene in the posterior silkgland cell are efficiently induced by "Kang-20" treatment.

STUDIES ON THE REGULATION OF THE GROWTH AND DEVELOPMENT BY TREATMENT WITH ANTI JUVENILE HORMONE (AJH) ANOLOGUE IN THE SILKWORM, BOMBYX MORI. Da-huan Zhuang, Mei-hua Xiang, Zhong-zheng Gui, Guo-hu Chen (The Sericultural Research Institute, Chinese Academy of Agricultural Sciences, Zhenjiang, Jiangsu 212018, China)

We have found some Anti Juvenile Hormone anologues: LIN_{11}, YA_{20}, CA_1, CA_2, CA_3, CA_4. They could induce the trimolter high efficiently. The trimolter could grow, develop and reproduce as normal. The economic characters of trimolter, which was induced by treatment with AJH, change according to the treatment instar: 2dn>3rd>4th larvae. The trimolter dietary efficiency per unit is higher by 4-9% than the check. The trimolter cocoon has better reelability, little size deviation of cocoon filament, better strength of raw silk elongation and cohesion. And the mechanism of influence of AJH has also been discussed.

A STUDY ON THE APPLICATION OF EXOGENOUS GENE TRANSFER BY MICROPROJECTION IN SILKWORMS (BOMBYX MORI). Zhiqi Meng[1], Shanlin Yao[2], Weimin Wang[1], Aihong Ye[1], Jing Liu[1] ([1]Zhejiang Academy of Agricultural Sciences, Hangzhou 310021; [2]Institute of Biophysics, Academia Sinica, Beijing 100080, China)

Trials of bombardment for gene transfer by microprojection were conducted on fertilized eggs at early stage (7-9 hours after oviposition) and the results showed: The tungsten projectile (with an average diametre of 2-4u) at the speed of 550-620m/s was capable of penetrating through the shells into the ova of silkworms and were evenly distributed in the ova-2-12 particles of the tungsten projectile were found in each of the ova through microscope examination. The development of the bombarded silkworm eggs proved normal with an incubation rate reaching 85. 50-90.78% and an average larva-pupa survival rate of 98.00-99.43% throughout the normal growth and development of the larva until the time of their silking and cocoon-building. The properties of the cocoons thereof in total cocoon weight, cocoon shell weight and percentage made no appreciable difference in comparison with those of the control. The process of gene transfer by microprojection therefore promises an effectual approach for exogenous gene transfer in silkworms.

COMPARATIVE STUDY ON PUPAL DEVELOPMENT OF ERI-SILK WORM, PHILOSAMIA CYNTHIA RICINI, UNDER DIFFERENT TEMPERATURE REGIMES Tang Ye-Zhong(Kunming Institute of Zoology, Academia Sinica, Kunming 650107)

Developmental rate and changing pupal weight were measured precisely under five regimes of temperature as follows: group A, B and C were at constant temperatures of 22°C, 25°C, 28°C, respectively, Group D and E were both under thermoperiod with cryophase: thermophase (22°C:28°C) and different temperature-alternating peroid: D for 24 hrs, E for 16 hrs. It was showed that developmental rate was approximately linear against the constant temperatures. For the three groups with the same mean temperature of 25°C, there were statistically significant difference between B and D、E, but no significant difference between D and E. It was suggested that the temperature-alternating period had little effect on the development rates. The pupal lightening rate, as an index of respiratory rate, fluctuated more strongly under thermoperiod than under corresponding constant temperature. For the developmental rate was proportional to the average lightening rate, it was proposed that thermoperiod could accelerate the development of insect. It was also found that there existed a rhythm of body temperature under constant temperature of 25°C.

STUDIES ON CHEMICAL COMPOSITION AND NUTRITION OF SIX SILKWORM CHRYSALISES: I. THE MAKE-UP OF AMINO ACIDS, Li Zheng(Hangzhou Silk Printing & Dyeing Joint Plant, Hangzhou 310015, China), Shao Yuanping(Heilongjiang Sericulture Direction Station), Ma Xiaofeng (Shanxi Academy of Agricultural Sciences), Cao Meixun (Shanghai Entomology Research Institute, Academia Sinica), Li Meiqui(Hangzhou Silk Printing & Dyeing Joint Plant, Hangzhou 310015,China), Lu Janming(Shanxi Academy of Agricultural Sciences)

In this paper the authors analyzed the chemical composition and the make-up of amino acids of the chrysalises of 6 silkworms. It was found that the contents of amino acids, the kinds and the ratios among the essential amino acids essentially meeted the requirements of FAO/WHO. Therefore, from the point of view of nutrition, the protein of silkworm chrysalis belongs to whole-value or biological value protein and merits further development and utilization.

Molecular Techniques in Genetic, Systematic and Physiological Researches on Acari

INTRODUCTION. M.J.Kaliszewski (Dept. Zoology, Brigham Young University, Provo. UT 84602, USA)

Recent advances in biotechnology, especially the advent of the polymerase chain reaction (PCR), have opened a new era in molecular acarology. Exciting progress is being made in such areas as phylogeny, physiology, ecology and applied acarology. The speakers in this symposium will highlight some of this research and point the way to new areas of investigation.

PERSPECTIVES IN STUDIES ON PHYLOGENY OF MITES AND OTHER ARACHNIDS BASED ON DNA SEQUENCES. M. J. Kaliszewski (Dept. Zoology, Brigham Young University, Provo, UT 84602) S. Seyoum (Dept. Zoology, Brigham Young Uitv. , Provo, UT,); and J. Kethley, (Field Museum of Natural History, Chicago, IL. USA)

Ribosomal genes have been used to examine higher level taxonomic relationships because of their ubiquity and high degree of conservation. Sequence data for the 18S ribosomal subunit of several arachnid orders and other arthropods is presented. Difficulties with data interpretation and phylogenetic reconstruction are discussed and the issue of mite monophyly is addressed.

ANALYSIS OF ARACHNID PHYLOGENT USING DNA SEQUENCES. Dr. J. Kethley,(Field Museum of Natural History, Chicago. IL. USA) abd DR. S. Seyoum (Ethiopia)

Relationships of the major groups of mites, monophyly of Acari as an "order" and relationships of Acari within Arachnida are all questioned. We address these questions based on DNA sequences. A sequence of approximately 200 bases of 18S rRNA from helix 43, including V8, through conserved helices 45, 46 and 30' into 47 and the beginning of V9 of standard eukaryotic secondary structure models was obtained from representatives of Xiphosura, Pycnogonida and all ordinal level taxa of Arachnida. More than 26% of the sites are informative (30 transitions, 35 transversions) . The high ratio of transversions to transitions supports the paleontological evidence of at least an early Devonian origin of arachnid lineages. Phylogenetic analyses indicate inclusion of Palpigradi in the cluster of Pseudoscorpiones + Opiliones + Solifugida. Synapomorphies unite prostigmatid Acariformes, oribatid Acariformes and Acariformes as a group with the above cluster. Several autapomorphies define Pycnogonida, Xiphosura, Amblypygida, Ricinulei, Araneae and Parasitiformes (Acari), but there are very few synapomorphies.

MOLECULAR APPROACHES TO STUDIES OF GUT CONTENTS IN MITES. D. - Walter (Monash University, Clayton, Australia), J. Tobolewski (Dept. Zoology, Brigham Young University, Provo, UT.) and M.J.Kaliszewski (Dept. Zoology, Brigham Young University, Provo, UT.)

Mite gut contents can be examined using the polymerase chain reaction (PCR) and primere designed to amplify specific host sequences. Such procedures can be applied to preserved material. The procedure is thus of potential usefulness in the determination of host specificity. Several examples are presented.

IDENTIFICATION OF A NOVEL TICK SALIVARY GLAND PROTEIN USING BIO'TICK'NOLOGY. Glen R. Needham and Deborah C. Jaworski (Acarology Lab, Department of Entomology, College of Biological Sciences, The Ohio State University, Columbus, Ohio 43210-1292, USA)

Tissue abundance problems have limited progress towards characterizing tick salivary gland secretory proteins that influence host hemostasis. Sequencing of DNA from a clone selected from a tick salivary gland expression library has provided preliminary evidence for a calreticulin-like protein. This finding was confirmed by probing a Western blot, having both fusion protein and salivary gland extract, with a highly specific antibody to rabbit muscle calreticulin. Calreticulin is a major intracellular calciumbinding protein in nonmuscle cells that is associated with the endoplasmic reticulum. Calcium is a key cofactor in numerous intracellular and extracellular physiological processes for arthropods and vertebrates. We discuss the potential roles for a calreticulin-like protein in the context of ixodid tick salivary gland physiology.

MITOCHONDRIAL DNA AND ARTHROPOD PHYLOGENY. D. Stanton (Dept. Biology, Brigham Young University, Provo, UT 84602, USA)

The potential usefulness of mitochondrial DNA for phylogenetic reconstruction in arthropods is explored. Several characters of potential usefulness at higher taxonomic levels are examined, including mitochondrial gene order and sequence data. Preliminary results are presented for sequence data from Cyt b and the 16S ribosomal genes.

Molecular Techniques in Genetic, Systematic and Physiological Researches on Acari

MITES AS A POTENTIAL VECTOR IN HORIZONTAL GENE TRANSFER: EVOLUTIONARY CONSEQUENCES. Marilyn.A. Houck (Department of Biological Sciences, Texas Tech University, Lubbock, Texas, 79409-3131, USA)

The bionomics of the mite, Proctolaelapos regalis will be discussed in terms of the potential effect of parasitism on horizontal gene transfer among Drosophila species. There is corroborating evidence, from independent research areas, that horizontal gene transfer of the P. transposable element has recently occurred between Drosophia melanogaster and a species of Drosophia from the Willistoni group. Using southern blot hybridization, PCR amplification and DNA sequencing, it was determined that samples of P. regalis associated with a P strain of D. melanogaster carried P element sequences. Similarly, Drosophia rDNA sequences were identified in P. regalis samples that had been associated with Drosophia cultures. Most consequentially, this mite has the morphology and behavior consistent with mechanical vectoring. It is also ecologically syntopic with D. melanogaster, both being native to southern North American. These results will be discussed in terms of the general attributes of P. regalis which led to its choice as a study organism, and the potential for such horizontal transfer in other insect-acarine interactions. Speculation concerning the relevance of horizontal transfer to host-parasite interactions will be offered.

SEASONAL POLYMORPHISM AND GEOGRAPHICAL VARIATION VARROA JACOBSONI AS AN ADAPTION IN UNPREDICTABLE HABITATS. Igor Akimov (Department of Acarology, Institute of Zoology, ASU Lenin Str 15, Kiev-30, Ukraine-252601)

The method of principal components discriminant analysis of morphological characters were used for study the variation of Varroa jacobsoni widely spread on the palearctic territory. It is established that all principal population characteristic undergo seasonal and geographical variation. The winter forms are more large and sclerotise.

For this species each variation form seems to support differently the parasites adaptation to the unpredictable habitats.

EVOLUTIONARY ADAPTATIONS OF MITES IN UNPREDICTABLE HABITATS: NEED FOR PHORESY. F. ATHIAS-BINCHE (Laboratoire Arago F-66650 BANYULS SUR MER FRANCE).

Phoresy is a phenomenon in which one animal actively seeks out and attaches to an other animal for transport. Phoretic dispersal is vital in mites, no winged animals, living in unpredictable or scattered microhabitats. Phoresy constitutes a very effective mean to colonize specific microsites with a maximal probability of success. It also allows foraging activity even in very transient habitats.

Phoresy, which might be probably euryxenous at its origin, seems to had evolved towards more specific relationships. The individuals which cannot recognize the adequate host will be eliminated. Such strong selective pressures select rapidly the most competitive lineages and may lead to host/phoront specificity.

The phoretic instars show various adaptations to host-seeking, attachment and survival during the migration. The adaptation to phoresy imposes physiological necessary for survival during the travel, especially to deficiency of food or moisture. Phoretic behaviour may be occasional, facultative or obligatory. Obligatory phoresy is seasonal or cyclical, this latter involving a synchrony with the host life cycle. Facultative phoresy, i.e. induced by density dependent factors or changes in environmental conditions, is prevalent in unpredictable habitats. It is a features of high adaptive significance.

Dispersal insures theoretically panmixis and genetic exchange. However, the life in scattered microhabitats means that the population is structured in demes, which is a cause of genetic drift. Migrations may lead to loss of genetic variability in the deme. In addition, some reproductive strategies and host/phoretic specificity may induce genetic drifts.

Factors Affecting the Dispersal of Spider Mites in Agroecosystems. J.Lindsey Flexner , Du Pont Agricultural Products, Stine-Haskell Research Center, Elkton Rd. , Newark DE. 19714 and **Peter H. Westigard**, Southern Oregon Agricultural Experiment Station, 569 Hanley Rd., Medford OR. 97502
The authors review biological and operational factors affecting ambulatory and aerial dispersal of tetranychids within and between crops. Methods of tetranychid dispersal including posturing and "spinning down" are discussed. Operational factors, such as the application of pesticides, may influence spider mite dispersal by stimulating mite development, suppressing spider mite natural enemies, and irritating or repelling tetranychids. Biological factors that influence spider mite immigration and emigration include: host plant desiccation, crowding, diapause and predator avoidance. Differences between spider mite dispersal patterns within natural versus agricultural ecosystems are outlined. Movement of spider mites between pear orchard groundcover and the tree canopy are highlighted.

ECOLOGICAL AND EVOLUTIONARY ADAPTATIONS OF MITES IN UNPREDICTABLE HABITATS. Barry M. Oconnor (Museum of Zoology, The University of Michigan, Ann Arbor, Michigan 48109-1079, USA)

Mites of the infraorder Astigmata are ancestrally specialized for the exploitation of unpredictable habitats. Most modifications are expressed in the deutonymphal instar which is highly specialized for dispersal, withstanding adverse conditions or parasitism. This paper reviews the different types of morphological adaptations of deutonymphal Astigmata in a phylogenetic context. From an ancestral morphology adapted for phoretic dispersal via attachment to sclerotized arthropod cuticle, astigmatid mites have evolved modifications which enable them to attach to membranous arthropod cuticle, arthropod setae, mammalian hair and the intrafollicular or subdermal tissues of vertebrates. Other astigmatid mite deutonymphs have evolved a regressive morphology which allows the inactive mites to survive long periods of unfavorable environmental conditions. Still others exhibit polymorphism in deutonymphal morphology which provides a species with both benefits.

DEUTONYMPHS, HABITATS AND LIFE HISTORY STRATEGIES OF SOME FREE-LIVING ASTIGMATID MITES. Norman J. Fashing (Department of Biology, College of William and Mary, Williamsburg, VA. 23187, U.S.A.)

When present in the life cycle of astigmatid mites, the deutonymphal instar (hypopus) is heteromorphic and often facultative. In contrast to other instars, deutonymphs have a rudimentary gnathosoma with no mouth and a solid gut. They are also extensively sclerotized and possess a caudoventral attachment organ. Deutonymphs are generally regarded as dispersal forms which develop in response to declining environmental conditions, thus allowing them to escape by means of phoresy on organisms, usually insects, which share their habitat. While this modus operandi is true for many species, the deutonymphal instar may play a different or modified role in the life history strategy of many others. Habitat (e.g, stable or transient, seasonal or constant, etc.) can be extremely influential in shaping the role of the deutonymph in the life history of a species. Examples include Naiadacarus arboricola (Acaridae) and Hormosianoetus mallotae (Histiostomatidae), inhabitants of water-filled treeholes, Sarraceniopus darlingtoniae (Histiostomatidae), an inhabitant of pitcher plants, and Hericia new species (Algophagidae), an inhabitant of sap flux on trees.

PARASITISM: ECOLOGICAL INTERACTIONS AND THE EVOLUTIONARY CONSEQUENCES OF PHORESY IN INSECT-MITE INTERACTIONS. Marilyn A. Houck (Department of Biological Sciences, Texas Tech University, Lubbock, Texas, 79409-3131, USA)

Hemisarcoptes is a genus of astigmatid mite which is a generialist predator of Diaspidid scale insects. In about 6% of the ontogenetic cycles, a heteromorphic deutonymphal stage (bypopus) is inserted in the developmental sequence. This stage is associated with beetles of the genus Chilocorus (Coleoptera: Coccinellidae). The deutonymph was considered to be an elattostase (no functional mouth parts) which uses the beetle for the purpose of dispersal (=is phoretic). Experimentation with Hemisarcoptes cooremani determined that deutonymphs do not survive to complete an ontogeny without some residence time on Chilocorus.A study determined that tritiated water moved from the hemolymph of the beetle to the mite during the residence time, and tissue sections indicate that a gut is present in the phoretic mite. This is the first experimental evidence that phoretic associations in astigmatid mites are not functionally restricted to dispersal alone. This discovery has significant implications for the potential chemical accomodation of Hemisarcoptes to its host. This is discussed in terms of the potential for transition from predation to parasitism, by way of the phoretic association.

XVIIS-3 Alternative Food of Phytoseiid Predators and Its Importance in Biological Control of Phytophagous Arthropods

Pollen as an alternative food source for predators: its effect on a thrips-predatory mite system.

Paul C.J. van Rijn (University of Amsterdam, Department of Pure and Applied Ecology, Kruislaan 320, 1098 SM Amsterdam, The Netherlands)

Studying the control of spider mites by predatory mites, a number of authors have reported that the control can be positively affected by the presence of other food sources for the predators, such as eriophyid mites, tydeid mites and pollen. So far no attempts have been made to give their arguments a more quantitative basis.
The major pest of vegetable crops grown in Dutch greenhouses, the Western Flower Thrips, *Frankliniella occidentalis*, is controlled by releasing high numbers of the predatory mite *Amblyseius cucumeris*. On sweet pepper crops better results are obtained than on cucumber crops. This difference can be attributed to the presence of pollen in sweet pepper crops, which is virtually absent in cucumber crops.
Studying the effects of pollen on this thrips - predatory mite system we obtained the following results: (1) The predatory mite can also utilize pollen for its development and reproduction. Consequently, at low prey densities, pollen will also increase the population growth of the predator. (2) Thrips consumption by this predator is little reduced when pollen is present. (3) In the greenhouse the predatory mites are arrested in areas with pollen alone, as well as in areas with thrips alone. (4) Both population models and greenhouse experiments show that predator populations can be maintained, even in the absence of prey, as long as pollen is available. (5) Assuming homogeneous distributions, predator-prey models show that the equilibrium prey density will always be lower when pollen is present, while for realistic parameter values, due to invulnerability of the older stages, this equilibrium is stable. (6) On the other hand: during the pre-equilibrium phase the reduction of the predation rate by pollen can cause a higher thrips damage level, due to a reduced resilience.

Transtrophic interactions in cassava.

Frank Bakker, Martha Klein; University of Amsterdam; Section Population Biology; Kruislaan 302; 1098 SM Amsterdam; The Netherlands.

Cassava plants exude phloem saps at the basis of the petioles of the youngest leaves. The effect of these nutrient-rich droplets on the interaction between the predatory mite *T. limonicus* and the herbivorous mite *M. tanajoa* was investigated in a semi-field setting. These two organisms were chosen as a model system due to their strong association with cassava. To experimentally test the hypothesis that exudate production is an adaptive trait in terms of extrinsic defense exuding plant parts were aborted. Subsequently exudate production was mimicked (or not) by applying honey droplets on the petioles. This treatment was selected because non-producing clones could not be found. The experiments indicated that: 1) The presence of exudate on otherwise clean plants does not prevent extinction of the predator population, but the *rate* of population decrease is consistently lower than when no exudate is present. 2) When a second food source enables the predators to reproduce, higher population densities are always attained when the sugar source is also present. 3) Higher predator numbers invariably coincide with lower herbivore abundance. 4) Per capita egg production is not higher when sugar is available. 5) Presence of honey leads to enhanced juvenile/adult survival or reduced emigration and thus to a higher number of female predators.
In interpreting the results careful attention was paid to the effect of cassava mildew because spores of this fungus were shown to be an adequate food alternative for the predator under study. The presence of this mildew (*Oidium manihoti*) hampered straightforward interpretation of some experiments but left the main conclusions unaltered.

SUITABILITY OF FOOD RESOURCES OF TETRANYCHIDS, POLLEN, AND ARTIFICIAL DIETS OF *AMBLYSEIUS OVALIS*. Chaining Shih (Department of Entomology, National Chung-Hsing Univ., Taichung, Taiwan 40227, China)

The responses of *Amblyseius ovalis* to its food resources were studied on 6 phytophagous mites, maize pollen, and 2 artificial diets. *A. ovalis* didn't complete its life cycle and laid no eggs, feeding on the artificial diets. A faster developmental rate, lower escaping rate, and higher survival rate were observed on *A. ovalis* feeding on *E. orientalis, O. mangiferus, O. taiwanicus* than on artificial diets and other natural food resources tested. After two days of preoviposition period, *A. ovalis* feeding on natural food resources reproduced an average of 2 eggs/female/day, but none on *T. kanzawai*. The variation of oviposition period and fecundity of *A. ovalis* on different tested food resources were estimated and discussed. The intrinsic rates and other life parameters were calculated from their life tables for each of 9 food resources. The life types of tested tetranychids varying the predatory activities and degrees of efficacy of prey ecounter of the predators were postulated as the results from inhibiting functions of prey webbing or nesting(life types), length and toughness of setae on idiosoma, microstructures at end of tarsus of propodosoma, and size or shape of idiosoma.

PATTERNS OF AGGREGATION AND UNDERLYING FORAGING BEHAVIOR IN THREE PREDACEOUS MITE SPECIES WITH DIFFERENT DEGREES OF POLYPHAGY. Zhi-Qiang Zhang and J.P. Sanderson (Department of Entomology, Cornell University, Ithaca, New York 14853, USA)

Responses of the predaceous mites Phytoseiulus persimilis Athias-Henriot, Typhlodromus (=Metaseiulus) occidentalis Nesbitt and Amblyseius andersoni (potentillae) (Chant) to densities of and cues associated with the phytophagous mite, Tetranychus urticae Koch, were studied in the laboratory. The oligophagous predator P. persimilis showed a direct density dependent foraging time allocation but a density independent spatial pattern of predation. The narrowly polyphagous predator T. occidentalis responded to the presence or absence of prey eggs but not to prey density and showed an inversely density dependent spatial pattern of predation. The broadly polyphagous predator A. andersoni showed a density independent foraging time allocation and an inversely density dependent spatial pattern of predation. Behavioral studies revealed that all three predator species entered into prey patches independently of prey density but left the patches non-randomly. Thus, aggregation in P. persimilis and T. occidentalis was primarily the result of non-random dispersal of predators from prey patches.

Population & Quantitative Approaches to the Use of Natural Enemies to Control Mites

PROSPECTS FOR BIOLOGICAL CONTROL OF SCARLET MITES ON TEA USING MASS REARED PREDATORY MITES. Gerrit van de Klashorst (University of Amsterdam, Department of Pure and Applied Ecology, Section Population Biology, Amsterdam, the Netherlands), Soelaksono Sastrodihardjo (Institute of Technology Bandung, West Java, Indonesia) and Dana Wrensch (The Ohio State University, Entomology Department, Columbus, OH, USA).

The scarlet mite, *Brevipalpus phoenicis* Geijskes, is the most damaging phytophagous mite on tea in Indonesia. Although it can be found everywhere in the plantations, the damage it causes is restricted to specific areas only. The presence of some native predatory mites (Fam. Phytoseiidae and Stigmaeidae) and their effect on the pest have been studied by Oomen (1982), who ascribed most importance to the Stigmaeidae. Our present aim is to establish a basis for applying augmentative releases of predatory mites.

Our field survey showed that representatives of both predacious mite families (more than ten species) were present all over the 600 ha sampled, together with *B. phoenicis*, Tetranychidae and Eriophyidae. In our leaf samples the Phytoseiidae were most important, with *Amblyseius deleoni* Muma & Denmark as the dominant species. This contrasts with the results of Oomen (1982) on the importance of the Stigmaeidae. However, he based his conclusions on beating samples, rather than on leaf samples.

Several predator species were succesfully reared using the MacMurtry & Scriven method. *A. deleoni* could thus be reared on scarlet mites, tetranychid eggs and pollen. The fact that it can be reared on pollen of broad bean and iceplant without prey mites, makes it a suitable candidate for mass rearing and augmentative releases.

INTEGRATED CONTROL OF MITES IN GLASSHOUSES. N. D. Atanasov (Plant protection institute, 2230 Kostinbrod, Bulgaria)

A new programme has been developed for integrated control of spider mites on cucumbers and tomatoes groun in glasshouses. It includes the application of a biotechnical method, race of Phytoseiulus persimilis Athias-Henriot- resistant to organophosphorous pesticides and selectiv acaricides.

After pucking out of cucumber and tomato plants in glasshouses, the biotechnical method is applied first for preventing the initial infestation of plants by mites. When first damadges caused by mites appear on the plants leaves, a certain quantity of predators belonging to the resistant race of P. persimilis selected by us is colonized. Later in spring and in the begining of summer if necessary, a treatment with the selective acaricides dicofol, tetradifon, hexythiazox and pyradaden is carried out.

By applying the programme, maximum protection of cucumbers and tomatoes from spider mites is achieved, using a reduceal amount of P. persimilis and pesticides.

CONSERVATION OF PREDACIOU MITES AMBLYSEIU ERARAI CONTROLLING RED MITES PANONYCHUS CITRI IN CITRUS ORCHARD. Zhi-yi Luo, Guo-pei Gan (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China), Yan-lin Zhang (Shanghai Qianwei Farm, Shanghai 201913, China)

Conservation of predacion mites Amblyseius eharai in citrus orchard were stadied for three years(1987-1989) in the Changxing Islant at Shanghai suburb. According to the investigation data the population of citrus red mites peaked from late June to middle July 1987. In unspray fields the predator could dominate cotrol red mites at lower density level whenever before or after the peak was occured. In 1988-1989 at the same field predator can control citrus red mites continuous. Under the rate of 1:20 or rather high rate between predator and citrus red mite the predatory mites could control citrus red mites below 1 to 2 mites per leaf. In spray fields use pesticide in early June every year predatory mites are certainly killed. Then citrus red mites will be lose control and pesticide are frequenitly required. It was also found that spaying pyrethroids two consecutive times cound stimulate a graet outbreak of citrus red mites.

RESISTANCE LEVELS OF Panonychus citri FROM SUZHOU CITRUS ORCHARDS TO FOUR PESTICIDES. Hui-qin Dong, Yan-yun Yang, Lai-rong Liang (Department of Environmental and Resources Biology, Fudan University, Shanghai 200433, China)

Two Suzhou populations of Panonychus citri(McGregor) collected from commercial citrus orchards were surveyed for resistance to four pesticides. A susceptible population collected from new citrus orchards which had no history of pesticide exposure was used in estimating resistance development. Both populations from orchards were tolerant to high concentrations of dicofol and amitraz. Resistance was also apparent to these materials, especially for dicofol which produced over 50-fold resistant level for one of the two populations. Moderate to low level of resistance developments were seen to field concetrations of monocrotophos and femvalerate. Results show the correspondence between resistance level development and pesticides field concentration as well as the history of pesticides use in this area.

CANDIDATES FOR BIOLOGICAL CONTROL OF MITE PESTS IN FLOWER BULBS. I.K.A. Lesna (1), C.Conijn (2), M.W.Sabelis (1)

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Flower bulbs are often intested by mite pests. Mesostigmatic predators (found in samples from flower bulb field and storage rooms) were tested in 3 series of laboratory experiments. Hypoaspis aculeifer was used against Rhizoglyphus robini (on lily) and Amblyseius barkeri against Aceria tulipae (on tulip). The possibility to control R.robini and A.tulipae in storage rooms are discussed.

THE SPIDER MITE PREDATOR PHYTOSEIULUS PERSIMILIS AND ITS ASSOCIATION WITH MICROORGANISMS

Gabriela Šuťáková

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Phytoseiulus persimilis is used in many countries for controlling Tetranychus mites. P. persimilis adult females and males from two colonies from Kiev (Ukraine) (1974-1987) and Ivanka pri Dunaji (Czecho-Slovakia) (1985-1989), were found to be heavily infected with rickettsia-like organism which we identified as Rickettsiella phytoseiuli. Adults of P. persimilis from the mite colony in Yerevan (Armenia) (1980-1988) were never found to be infected with rickettsiellae. We have also described the presence of symbiotic microorganisms in infected and uninfected females P. persimilis.

According to recent information (Alberta Environmental Center, Vergeville, Canada) in the present time there are major problems associates with poor quality of commercially produced mites from Canadian and American sources. Large mortality of these mites was connected with Microsporidia infection.

These date show the need of detailed investigation on P. persimilis and its pathogens before their use in biological control.

XVIIS-4

Population & Quantitative Approaches to the Use of Natural Enemies to Control Mites

Conservation and Augmentation of Natural Enemies to Control Spider Mites in Agroecosystems: Putting the "I" in IPM. **J. Lindsey Flexner** , Du Pont Agricultural Products, Stine-Haskell Research Center, Elkton Rd. , Newark DE. 19714; **Peter H. Westigard**, Southern Oregon Agricultural Experiment Station, 569 Hanley Rd., Medford OR. 97502; and **John E. Dunley** Department of Entomology, Oregon State University, Corvallis, OR. 97331. Biological control of spider mites in agroecosystems has been one of the most successful examples of integrated pest management to date. Predatory mites have been so effective at controlling tetranychids on apples in the Pacific Northwest of the U.S. that acaricides have not been used in some orchards for over twenty years. However, the number of acres that are treated with synthetic chemicals for spider mite control annually still greatly outweighs the acreage under biological control. The authors review the key biological and operational factors responsible for the successes and failures of tetranychid biological control in several U.S. cropping systems. This paper focuses on the the relationship between predator prey interactions, acaricide resistance, and the potential impact of new pesticide regimes on existing spider mite biological control programs. Recent work on the dispersal of phytoseiids in and between agroecosystems is highlighted.

LYME DISEASE RESEARCH IN JAPAN. K. Uchikawa, K. Miyamoto (Department of Parasitology, Shinshu University School of Medicine, Matsumoto 390, Japan)

In succession to the first ease report of Lyme borreliosis form Japan in 1987, a few cases have been diagnosed sporadically form various areas spreading south to Kagoshima and north to Hokkaido. Their clinical symptoms were usually mild and included frequent ECMs and, at the worst, Bell's palsy. Incongruous with the above, the spirochetes identified serologically with *Borrelia burgdorferi* have been recovered in *Ixodes persulcatus* and *I. ovatus* at rates of 20-30% in many areas where the surveys were made. Rodents also yielded the same spirochete and mammalian hosts including man were seropositive for the spirochete at high rates. Biochemical analyses of the spirochetes are in progress, yet the virulence of the Japanese strains of *B. burgdorferi* is not evaluated yet. It is of primary importance in Lyme borreliosis to make a correct diagnosis at the early stage of the disease with mild manifestations. Although a positive serological finding is thought to be indispensable for the diagnosis in Japan, ECM tissues yield often the spirochete. Meanwhile, The Japanese workers show that their microcapsule agglutination test is more sensitive than ELISA for detecting specific antibodies in patients at an early stage of the disease.

LYME DISEASE IN CHINA. Cheng-Xu Ai, Shi- ping Chen(Institute of Basic Medical Sciences, Beijing 100853, China), Wei- fen Zhang(Institute of Hysteris, Beijing 10094, China)

Lyme disease was not reported in China until recently Ai et al first noted the indigenous Lyme disease cases in Hailin County, Heilongjiang Province in 1985 and further investigation confirmed the presence of the disease in this area. 302 cases of Lyme disease were observed in Hailin County in 1986. Since then the distribution area of the human cases enlarged constantly during the five- year period. Cases have been documented in the northeast, northwest and southeast of China and in the suburbs of Beijing. Borrelia burgdorferi spirochetes were isolated from the blood of human cases in Heilongjiang and Hebei Porvinces and in the suburbs of Beijing. Ixodes persulcatus is a primary vector of Lyme disease in the northeast and northwest of China; so are Haemaphysalis longicornis and H. bispinosa in the north and southeast of China. Immature I. persulcatus were most abundant on Eutamias sibiricus and less aboudant on Apidemus agarius, A. speciosus and Clethrionomys rufocanus. The seasonal abundance pattern of the larvae appears a bimodal peak but that of the nymph is monomodal during spring. The peak of the nymph precedes the first one of the larvae by one month. The hosts of nymphal and adult H.longicornis are domestic animals. Adult tick appears one peak, while the nymph exhibits bimodal peak in the suburbs of Beijing. These results show that natural foci of Lyme disease exist in wide areas of our country.

LYME DISEASE IN THE USSR. E. Korenberg (Gamaleya Institute of Epidemiology & Microbiology, Academy of Medical Sciences of USSR, Moscow 123098, Russia)

The infection was verified serologically in the USSR in 1985. Now it is known to be widely distributed through forest belt from Kaliningrad region and Baltics in the West to Primorye Territory and South Sakhalin in the East. The main vectors are Ixodes persulcatus and I. ricinus tick species from which borrelia were isolated in different regions. In the vast territory of East Europe there are foci with these two vector species. The infection rates of adult unfed ticks are varied in different regions. The rates are usually higher in I. persulcatus than I. ricinus tick species. The possibility of stage to stage transmission was demonstrated in I. persulcatus. From the point of morbidity this infection is obviously the leader in comparison with other tick-borne diseases and it has the most important plase amongst the all zoonoses with natural focality.

LYME DISEASE AND AUSTRALIA – AN UPDATE. R.C.Russell (University of Sydney, Department of Medical Entomology, Westmead Hospital, Westmead, N.S.W. 2145, Australia)

Patients with a condition thought to be Lyme disease were first reported in Australia in 1982. Further clinical cases were reported in 1986 from the south and central cost areas of NSW, and in Queensland in 1987 a number of patients with raised antibody titres were recognised. In 1988 a diagnostic serological service for suspected Lyme disease was established in Sydney and patients with positive serology have been reviewed clinically; a serological survey of blood donors was also undertaken. More than 1200 suspected cases have been screened and serology has continued to indicate Borrelia burgdorferi–type infections in about 3% of patients. However the serology is problematical and is based on North American antigens because the causative organism for the infection in Australia has not yet been identified. Research into identifying the causative organism in Australia has been underway for the past 3 years. Large numbers of ticks have been collected from coastal areas of eastern Australia where putative cases have occurred. A number of spirochaete–like organisms have been isolated from ixodid ticks collected in areas throughout this 'endemic' range. There have been attempts to characterise these spirochaetes, and some isolates show similarities to Borrelia genus and possibly to B. burgdorferi from the northern hemisphere. None have yet been shown to be associated with human infection.

The paper will give a perspective on Lyme disease in Australia, and detail the results of the investigations seeking the causative agent.

Ecology of Lyme borreliosis in Northern Europe - an overview. Thomas G.T. Jaenson, Hans Mejlon, Lars Tälleklint (Section of Entomology, Department of Zoology, University of Uppsala, Box 561, S-751 22 Uppsala, Sweden)

Lyme disease is prevalent within the distributional areas of *Ixodes ricinus* in Denmark, Finland, Norway and Sweden. It is estimated that more than 1000 cases of human Lyme disease occur each year in Sweden. During the last decades the prevalence of this zoonosis may have increased due to a drastic increase of the roe deer population resulting in increased abundance of potential vectors. The main vector is *Ixodes ricinus* and the main vertebrate reservoirs are thought to be small mammals, particularly *Clethrionomys* and *Apodemus*. However, *B. burgdorferi*-infected ticks occur on islands where rodents are absent. The season of transmission of *B. burgdorferi* to humans depends on the temperature in the vector's environment. In warm years in southern Sweden transmission may take place in all months. In northern Sweden transmission is usually limited to June-August.

LYME DISEASE IN NORTHEASTERN AND NORTHCENTRAL USA. Durland Fish (Medical Entomology Laboratory, New York Medical College, Valhalla, NY 10595 USA)

Lyme disease is epidemic in the northeastern and northcentral US where 90% (35 200) of the nation's human cases have been reported since 1982. The epidemic is caused by increased density and an expanding range of the tick vector, *Ixodes dammini*. The situation is most acute in the northeastern states where increased suburbanization and residential development of recently reforested landscapes has resulted in maximizing human exposure to potentially infectious tick bites. Two counties suburban to New York City alone account for about 30% (2550) of the 8500 national case reports each year. Intensity of transmission is much less in the northcentral states where Lyme disease results from rural occupational and recreational exposure, rather than peridomestic exposure. Risk for Lyme disease in both areas is strongly seasonal with 80% of dates of onset coincident with the activity of the nymphal stage during June and July. Stage-specific infection rates of *Borrelia burgdorferi* are 0.5%, 23%, and 50% for larvae, nymphs, and adults, respectively. A 2-year life cycle, which allows nymphs to feed before or concurrent with larvae, is responsible for maintaining high infection rates in the near absence of transovarial transmission. Small and medium-sized mammals, as well as birds, act as natural reservoirs of infection. Preventive measures are limited to personal protection from tick bites and residential area applications of acaricides. Research on more environmentally compatible methods for tick reduction is in progress.

LYME DISEASE IN SOUTHEASTERN USA. JAMES H. OLIVER, JR. GEORGIA SOUTHERN UNIVERSITY, STATESBORO, GA. USA.

Serological screening of feral mammals for antibodies to Borrelia burgdorferi indicates its presence from Coastal Maryland to central Florida. During 1991 seven spirochete isolates were recovered and cultured; five from barrier islands and coastal Georgia and two from Florida. Isolates 1,2,5,6, and 7 are from Peromyscus gossypinus, isolate 3 from Sigmodon hispidus and isolate 4 from a questing male Ixodes scapularis on vegetation. Isolates 1,2, and 4 are confirmed as B. burgdorferi and the other isolates are currently being identified. Needle or tick transmission in the laboratory were successful. Other research involving experiments on hybridization, assortative mating, multivariate morphometric analyses, chromosomes, isozymes, life cycles, host preferences and vector competence of B. burgdorferi indicate that Ixodes dammini (the reported vector of B. burgdorferi in northeastern and northcentral USA) is conspecific with I. scapularis. The name I. scapularis has priority over the name I. dammini.

Lyme Disease in the Western United States of America

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Lyme disease in the United States has become an increasingly important public health problem in the past 10 years as the geographic distribution has expanded and the incidence of disease has increased. In 1992, it is the most important vector-borne disease in the United States. Although the distribution of Lyme disease has not been accurately defined, most cases are reported from states located in the northeast/north central, upper midwest and the northwest. The natural history and ecology of the disease varies considerably in these areas. In the western United States, *Ixodes pacificus* is the principal tick vector of human disease and most transmission is associated with recreational activities. *I. pacificus* is widespread in the western U.S.; 54 of 58 counties in California contain this tick vector, as well as areas in Oregon, Washington, Arizona and Utah. Natural infection rates in this species are low (1-2%), however, and the primary vertebrate hosts of larvae are either not competent reservoir hosts for *Borrelia burgdorferi* (lizards), or have very low *B. burgdorferi* infection rates in nature (*Peromyscus*). Woodrats and kangaroo rats have the highest natural infection rates and are competent reservoir hosts for *B. burgdorferi*, but rarely are infested with *I. pacificus*, suggesting that other nest-dwelling tick vectors are important in the maintenance cycle of *B. burgdorferi* in the western United States. Other epidemiologic and ecologic characteristics of Lyme disease in the western part of the country will be discussed.

Pillow Mite Indices in China. Ting-huan WEN (Shanghai Medical University, Medical Acarology Laboratory, Shanghai 200032, China)

Pillow is a relatively stable ecological niche for the mites, man has to contact with it intimately by night. It should be a risk factor of exposure to the mite allergens for the atopic patients. Mites per pillow was proposed as an index of the mite density and surveys were carried out in 14 cities in China. By hand brushes the dust from the innerside of a pillowcase and its counter surface of the pillow was collected. All sampled houses were same new style flat of median rank, one pillow was examined for each house. Around 40 pillows were examined for every city. The mites in the pillow dust were identified.

The results showed the mite infestation rates ranged 35.3-86.7% in various cities except two remote areas. The mite-pillow indices were ranged 0.7-28.9 and generally higher in the northern and western cities than the southern and eastern parts of the country.

The pillow mites were also investigated in two rural areas. In East China (Xuanzhou) 78%(117/150) of pillows were infested with mites with an index of 8.64. A total of 1297 mites belonging to 11 species were sampled from the pillow dust, Chortoglyphus domicola and D. pteronyssinus were most abundant. Another study was conducted in North-East China (Harbin). The mite infestation rate of the pillows in the traditional fire-couches or kang in old style houses was 47.8% with an index of 22.4 which is obviously lower than that in the modern beds. The pillows stuffed with buckwheat husks were the most suitable microhabitat for mite proliferation.

The trend of construction of the new flat houses in all the cities in this country might be a risk factor of increasing the prevalence of mite atopic diseases.

Mites in Chinese Herb Medicine. Sui-gong Yin (Shenyang Agricultural University, Shenyang 110161, China), Zhen-xu Qiu, Bin Teng, Hui Wang (Shandong Traditional Chinese Medical College, Jinan 250014, China)

Traditional Chinese medicinal herb is one of the important natural resources widely used for the treatment and prevention of diseases, as well as the health protection in the Oriental world. It is a precious heritage sharing an rather important part in the traditional Chinese medicine. The problem of contamination of the herbs with mites has been notified by the Ministry of Public Health of this country.

The mite contamination rate of the ready made herb medicine was 4.1%, while of the crude herbs was 68.2%. Forty species of mites belonging to 4 suborders, 19 families and 30 genera had been identified from the different kinds of herbs. Surveys of the mites in herbs in Shenyang and Jinan had been carried out separately in 1989. 22 kinds of herbs were examined in Shenyang. 15 species belonging to 2 suborders, 9 families and 13 genera were identified. The predominant species were Cheyletus eruditus, C. malaccensis and Diamesoglyphus sp. In Jinan a total of 1367 mites (about 80%) were identified from 8 kinds of herbs, the dominant species were tarsonemid, acarid and oribatei mites. From the flower of Sophora japonica were collected 771 mites of which 65.76% were oribatids (Aphelacarus sp.), and from Taraxacum mongolicum were sampled 203 mites of which 44.33% were Tarsonemus granarius. Other than the dominant species were C. malaccensis, C. eruditus, Lepidoglyphus destructor, Histiostoma feroniarum, Tyrolichus casei, Suidasia nesbitti, pyroglyphids, etc.

Different kinds of herbs may be polluted by the mites usually with different dominant species in different regions and different seasons.

HOUSE DUST MITE ALLERGY IN CALCUTTA : EVALUATION BY SKIN PRICK TEST AND RAST

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Occurence of immediate hypertensitivity reaction towards house dust mites was measured on dust sensitive asthmatic patients by skin prick test and RAST. Among sensitive patients,48%,45% and 80.15% responded positively to house dust,Dermatophagoides pteronyssinus and D.farinae mite allergens respectively by skin prick test.The corresponding figures in case of RAST were 79.77%,71.91% and 88.76% respectively.Patients' sera contained significantly elevated ($p \ll 0.01$) total IgE level than the control sera.Analysis of data indicates that the total number of positive patients and the number of patients with major reaction by both methods was maximum against D.farinae followed by house dust and D.pteronyssinus highlighting the superiority of D. farinae allergen over the others.Study further indicates that of the two diagnostic methods employed for predicting immediate sensitivity,RAST is more sensitive and efficient.It is suggested that the control of these mites may be taken as an effective strategy in the prophylactic management of bronchial asthma.

HOUSE DUST MITES IN HOUSES OF ALLERGIC CHILDREN IN GAZA.

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Three-hundred allergic children aged 3-15, and 100 age-sex neighborhood matched controls were studied for environmental risk factors for asthma during the period of 1986-1987. Significantly more cigarettes were smoked in the houses of allergic children. House dust samples from 20 allergic and 20 non-allergic children were examined for the presence of house dust mites. Mites were found in all samples examined. Twelve species of mites were identified. Dermatophagoides pteronyssinus was the most prevalent species (97%). The number of mites per gram dust were between 20 and 3,800 (average 447) in the houses of allergic children and between 40 and 2,040 (average 399) in those of controls. House dust seems to be one of the most important sources of allergy in Gaza. In 98% of asthmatic patients the symptoms were worse after exposure to house dust. In 97% of the cases the symptoms were more severe at home and in over 50% the symptoms persisted all the year round. Although most of the children in Gaza are exposed to a high number of mites in their homes, apparently those who are genetically predisposed and who are exposed to environment tobacco smoke are more prone to develop allergic symptoms.

HOUSE DUST MITES AVOIDANCE IN ITALY. **F. Ottoboni (Lofarma Allergeni, Milano, Viale Cassala 40, 20143, Italy). I.E. Rigamonti, G.C. Lozzia (Istituto Entomologia Agraria, Università di Milano, Milano, Via Celoria 2, 20133, Italy).**

Domestic mites are the most remarkable cause of allergy in Italy. The most important species responsible of the fenomenon are: *Dermatophagoides pteronyssinus, D. farinae, Euroglyphus maynei, Acarus siro, Tyrophagus putrescentiae, Glycyphagus domesticus, Lepidoglyphus destructor* and *Gohieria fusca*. The objects of this work were:

1) to evaluate the effect of conventional sanitary measures (use of detergents and household cleaning solutions) to create an environment poor in allergens through RAST inhibition;

2) to evaluate the possibility of using essential oils in order to get rid of domestic mites.

The most effective measures for the prevention of mites growth are: weekly change of sheets and pillow-cases, elimination of natural fibres carpeting, use of vacuum cleaner with HEPA filter. On the contrary, mites growth is favoured by double window-panes. Anionic and non-ionic detergents, pyrophosphate, EDTA and sodium lauril sulphate did not show neither a reducing activity on allergen proteins nor an acaricidal one. Among ten tested essential oils, the most effective ones resulted: caraway oil, garlic, black pepper, Perù balsam. Caraway oil was further analyzed in its main components, carvone and carvacrolo, but single compounds resulted less effective. Caraway oil was later formulated at 1% with ammonium salts and detergents, saving its acaricidal activity and permitting allergen reduction. The essential oils combined with household cleaning solutions could help to reduce sensitization risk in domestic mites allergic subjects.

THE REDUCTION OF HOUSE DUST MITE ALLERGENS THROUGH CLEANING

drs W.A.D. van der Hoeven and dr R. de Boer (Dept. of Pure and Applied Ecology, University of Amsterdam, Kruislaan 302, 1098 SM Amsterdam, The Netherlands)

Rugs can be rendered unsuitable as a habitat for house dust mites through cleaning.
Removal of the food for house dust mites seems to be the most plausible explanation for this. Our research is focussing on two questions:

(1) How quickly is the quantity of food restored after a rug has been cleaned thouroughly?
(2) Does the food for house dust mites in a rug accumulate during the winter, when the growth of a mite population is suppressed, due to a low ambient air humidity? If this is true, a well timed cleaning action could have a great impact on the development of a mite population in the subsequent summer. Our latest results will be presented.

DOMESTIC MITES: THEIR ROLE IN RESPIRATORY ALLERGY.
Frits Th.M. Spieksma (Lab. Aerobiology, Dept Pulmonology, University Hospital, Leiden, The Netherlands)

Domestic mites are free-living mites regularly found in the home environment, and belonging to two ecologically defined groups: all species of house-dust mites and some species of storage mites. The term house-dust mites should be used for those species of the nest-dwelling family Pyroglyphidae which have repeatedly been found in the human "nest", like *Dermatophagoides pteronyssinus, D. farinae, D. microceras,* and *Euroglyphus maynei*. Those storage mites which have been reported from house dust, farm dust, etc. are also to be reckoned amoung domestic mites, like *Acarus siro* and *Tyrophagus putrescentiae* of the family Acaridae, and *Lepidoglyphus destructor* and *Blomia kulagini* of the Glycyphagidae. In the moderate climate zones of the world pyroglyphid house-dust mites are most abundant, while storage mites may be more abundant in wet tropical regions.

Respiratory allergy to products of domestic mites is one of the most common allergic diseases. Particularly house-dust mites are very often the cause of allergic rhinitis and asthma in sensitive people. Although the allergens clearly show species-specificity, cross-allergenicity between species of the same family can be relatively strong. Cross-allergenicity between families is less outspoken, but not completely absent. In clinical work it is important to assess the identity of the mite species to which the patient is exposed to. A system of pictorial keys for the identification of domestic mites has been constructed recently.

DOMESTIC MITES AS ENVIRONMENTAL ALLERGENS IN JAPAN: PRESENT SITUATION AND PREVENTIVE MEASURES. Akira ISHII (Dept. Parasitol., Nat. Inst. Hlth., Tokyo 141 Japan). N.Ohta, T.Aji, H.Matsuoka, T.Ono(Dept. Parasitol., Okayama Univ. Med. Sch., Okayama 700 Japan)

Domestic mites, especially genus Dermatophagoides has been recognized as the most important allergen in respiratory allergic diseases in Japan since mid 1960's. Many studies have revealed epidemiological, ecological, clinical, allergological situations in Japan and biochemical allergen analysis has brought a new aspect of treatment. Mite allergy problem in Japan has now become a public health problem. Mite allergen avoidance is a keen interest of mothers of asthmatic children which number is steadily increasing in recent years.

Measurement of mite numbers in house dust was first attempted by counting under microscope and immunological mite allergen measurement has been introduced utilizing several methods. Standardization of the method is now under investigation. First, straw mattress of "Tatami" was a target of high mite content and then carpet was the next problem. In recent years, Japanese bedding "Futon" is a new target of mite avoidance by interested mothers.

In outdoor environment also we could detect mite allergen in minute particles trapped in high volume air sampler.

Proper management of living environment of allergic patient by such as intensive sweeping, changing of flooring and washing of beddings should be attained by correct measurement of mite allergen content in his/her house and even outdoor surroundings.

EXPOSURE TO HOUSE-DUST MITES AND RISK OF DISEASE.
J. Korsgaard, Aarhus Municipal Hospital, Denmark.

The association between exposure to house-dust mites and consequent risk of allergic diseases is reflected by the geographical and climatological differences in occurrence of mites in human dwellings and corresponding differences in the frequency of mite allergic diseases.

Epidemiological population studies on daily mite exposure in dwellings and risk of disease in a defined geographical area provides precise information on disease risk with the definition of threshold limit values.

Several studies in different countries have investigated the disease risk for chronic asthma in relation to domestic exposure to house-dust mites. For asthma the threshold linit value for mite exposure below which there is no increased mite asthma risk is 100 mite per gram dust. With increasing exposure above this level the relative disease risk increases to a maximum of 7.8 which corresponds to an 8-doubling of mite-asthma in populations exposed daily to more than 1.000 mite per gram dust.

Likewise for adult patients with moderate to severe atopic dermatitis there seems to be, as for mite-asthma, a dose-response relationship between exposure and disease. As for mite-asthma the suggested TLV in case of atopic dermatitis is 100 mites per gram dust with a maximum relative risk of 6.4 when exposed to more than 1 000 mites per gram domestic dust.

Allergenicity of Euroglyphus maynei, and its immunological relationship to Dermatophagoides farinae and D. pteronyssinus. Larry G. Arlian, Department of Biological Sciences, Wright State University, Dayton, Ohio 45435 USA.

The house dust mite *Euroglyphus maynei* (EM), is prevalent in homes in some geographical areas in the U.S., England, Western Europe and other parts of the world. In many locations EM is the dominant species or constitutes greater than 30% of the total dust mite population. However, the allergenicity of EM is relatively unknown. The purpose of this study was to evaluate the antigenicity and allergenicity of EM and to determine the cross-reactivity between EM and *Dermatophagoides pteronyssinus* (DP) and *D. farinae* (DF). Crossed immunoelectrophoresis (CIE) and crossed radioimmunoelectrophoresis (CRIE) were used.

Extract prepared from EM bodies contained more than 30 antigens, at least 10 of which bound circulating IgE in the sera of the EM-sensitive individuals. Of the 34 sera tested, 76% showed circulating IgE directed at 3 or more EM antigens. One antigen was a strong allergen for 88% of the individuals. However, several different antigens were recognized as strong allergens by many of the individual sera.

Heterologous CIE reactions of DP or DF extract and EM antiserum, and the reciprocal reaction showed more than 15 cross-reacting antigens. Many of the cross-reacting antigens bound IgE. This study revealed that: 1. EM was the source of more than 30 antigens; several of which were allergens with at least 1 being recognized as a strong allergen by most sera. 2. Many EM antigens cross-reacted with antigens of DP and DF; several of these were cross-reacting allergens. 3. EM was also the source of species specific allergens.

ANALYSIS OF THE HOUSE DUST MITE ALLERGENS IN JAPAN.

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Attempts were made to analyze the house dust mite allergens in the crude mite extract of the body of Dermatophagoides farinae, employing radioimmunoelectrophoresis or the RIEP. Four major allergenic proteins were identified. They were designated Me1, Me2, Me3 and Me4, according to their electrophoretic mobility. The molecular weight, determined by radioimmunoblotting, were 17KD, 27KD, 43KD and 80KD, respectively. The first and the second major allergens were Me1 and Me2. Recent study has shown that Me1 belongs to the Der II group while Me2 belongs to the Der I group of the mite allergens. Studies are underway to produce recombinant forms of these major allergens and to determine their biological activities.

During the study of non-specific irritable substances in the crude mite extract, three kinds of protease were identified. Me2 or the Der f 1, seemed to correspond to one of the three protease activity, the molecular weight of which was about 20KD. Studies with different substrates and inhibitors suggested this protease to be an SH-protease. On the other hand, Me1 or the Der f 11, showed no protease activity.

MEASUREMENT OF GROUP I ALLERGEN OF DUSTS OF SEOUL, AND ITS MONTHLY VARIATION. Chein-Soo Hong,M.D., Mi Kyung Lee, M.D.,(Department of Internal Medicine,Yonsei University,College of Medicine, Seoul,Korea)

House dust mites are the most prevalent inhalent allergens in Korean respiratory allergy patients. The living style, especially bedding is quite different from western. The room floor is consisted of Ondol which is dried and smoothly surfaced. It is warm in the winter for heating. Bed clothes-mattresses and quilts are stored in the cabinet during daytime. We have four seasons in a year. Summer is humid and hot. Two species of Dermatophagoides have been discovered in house dusts. With the method using monoclonal antibody we measured the amount of *Der fI* in the house dusts and studied its variation in the months. We collected 688 dust samples of sofas, livingrooms, bedrooms, bedclothes and carpets from 20 houses during one year. Over 50 % of dusts from sofas, bedclothes and carpets had *Der fI* ≥ 2 ug/gm of dust. 11.7% of all samples noted *Der fI* ≥10 ug/gm of dust. The lowest level of *Der fI* in a year noted in samples collected on May in all kinds of sources. During summer there noted higher levels of *Der fI* than other seasons. 20 % of dust samples(115) collected from July to August had *Der fI* ≥ 10 ug/gm of dust. The dusts from sofa contained the highest level of *Der fI* (mean;4.69 ug/gm of dust) and they were relatively constant in level of Der fI through a year.

In house dusts of Korea the allergen amounts of house dust mites were all the year round enough to sensitize and to provoke allergy symptoms in patients, even though there were higher amounts during summer. The sofas coverd with clothes and bedclothes would be the most important sources for house dust mites.

The gut cell membrane of ticks and insects: a site for immunological attack

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A recombinant vaccine against the tick *Boophilus microplus* is currently undergoing extensive evaluation. The development of this vaccine has demonstrated the feasibility of vaccination against at least some of the many haematophagous arthropods that are important pests to man and domestic animals.

Understanding the nature and mechanism of this form of immunological control may aid its extension to other disease organisms. During development of this vaccine, a single, protective protein, the Bm86 protein, was identified. This is known to be located on the plasma membrane of one cell type in the tick gut. The structure of the protein is consistent with its having a specific, critical biochemical function in the tick. It might therefore be expected that it would be conserved across species. Evidence will be presented that strong sequence conservation occurs.

Nevertheless, not all appropriately located, biochemically functional proteins on gut cell membranes are protective. Examples will be given.

The Peritrophic Membrane of Insects, Its Structure, Formation, Composition and Permeability.

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After passing through the epicuticle-lined pharynx and oesophagus, an insect's food then contacts the peritrophic membrane (PM). This inner tube-like lining of the gut is present in most insect species, and appears to be important in a number of ways for the insect's well-being. Perhaps the most important function is to provide compartments for enzymic digestion and counter-current flow of enzymes, digestion products and ions. Because of this it is a prime target for ingested insecticides. We have applied light and electron microscopy, including lectin/FITC and lectin/gold, to better understand the structure and composition of the PM in species of Lepidoptera, Diptera and Coleoptera. To determine the permeability of the PM in the blowfly *Lucilia*, buffalo fly *Haematobia* and cotton bollworm *Heliothis*, insects were fed on insulin-coated colloidal gold of different diameters and prepared for electron microscopy. When lectins were fed to flies together with the colloidal gold, the permeability of the PM to colloidal gold was greatly depressed. These results are discussed in relation to the importance of the PM for insect digestion.

Aspects of Midgut Physiology in Blood-sucking Insects.

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Potentially, blood-sucking insects feeding on vertebrates are open to attack from the immunological agents ingested with their blood meal. Choice of target proteins for vaccine development must rely either on luck or targeting or specific likely candidates. Clearly the intestine as the interface between blood meal and insect is a good place to search for such potential target proteins. With this in mind I will use my talk to briefly review symbiotic micro-oranisms and their role in blood-sucking insect nutrition, blood meal dehydration and associated events, blood cell lysis and the digestive enzymes of blood-sucking insects. Each of these aspects of blood meal management appear to me to be not only potentially available to immunological agents in the blood meal but also to be sufficiently important that impairment of function would have serious consequences for the insect.

Structure and Biochemistry of Midgut Cells in Blood-sucking Insects

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Once a blood-sucking insect ingests a bloodmeal, a whole range of predictable events are triggered in practically all tissues, including the midgut. Ultrastructural modifications include those associated with protein synthesis, including production of digestive enzymes (eg. changes in the rough endoplasmic reticulum), synthesis and release of peritrophic membrane material, removal of water from the bloodmeal, and eventual absorption of digested products.

The activities of several enzymes - those involved in ion and water transport, and protein and sugar digestion - can all be correlated with their role in post-feeding processes by either their timing of activity or their localisation in the midgut cells and lumen.

Less clearly understood are the structural molecules present in the insect midgut. The basal lamina has been shown to be composed of a number of classical extracellular matrix molecules - eg. laminin, fibronectin, chondroitin sulphate - while the microvillar surface of the midgut cells exposes a range of sugar residues to the lumen. The roles of these molecules in maintaining cell function and in vector parasite interactions will be discussed.

Cell Membrane Receptors and Regulation of Cell Function in Ticks and Blood-sucking Insects.

John R. Sauer (Department of Entomology, Oklahoma State University, Stillwater, Oklahoma 74078, U.S.A.).

Hormones, neurotransmitters, growth factors and other agonists bind to receptors on the external surface of a cell. Many extracellular signals are transmitted across the cell membrane by mechanisms that use second messenger molecules that eventually cause the biological response. Evidence of cell membrane receptors in blood-sucking arthropods is reviewed.

In ticks, a D-1 dopamine receptor linked to activation of adenylate cyclase and increase in salivary gland cyclic AMP controls fluid secretion by the salivary glands. A peptide factor from the tick synganglion stimulates increased turnover of phosphoinositides and an increase in inositol phosphates suggesting an additional receptor linked to activation of phospholipase C in the salivary glands of ticks. Other evidence indicates existence of a receptor tyrosine kinase and stimulation of protein tyrosine phosphorylation in the salivary glands, a feature common to the mode of action of growth factors.

Generic approaches to obtaining efficacious antigens from vector arthropods.

C.M. Elvin, D.H. Kemp (CSIRO Division of Tropical Animal Production, Long Pocket Laboratories, Indooroopilly, Queensland, Australia).

Ectoparasites are still controlled mainly by chemicals such as organophosphates and synthetic pyrethroids. The efficiency of such chemicals is gradually being eroded by the development of resistance in desired target species and there is a demand throughout the world for reductions in pesticides residue levels. This is a major incentive to develop new pest control measures that are safe and sustainable.

A promising new method in parasite control is vaccination of the host with "concealed" antigens which the parasite does not normally expose to the host immune system. Immunoglobulins ingested with the blood meal can then attack key molecular targets in the parasite. For example, a vaccine against the cattle-tick, *Boophilus microplus*, has been developed using a recombinant antigen derived from tick gut cells (Willadsen *et al.*, 1989).

Development of similar vaccines against the buffalo fly (*Haematobia irritans exigua*) and the sheep blowfly (*Lucilia cuprina*) is now underway at CSIRO. Polymerase chain reaction (PCR) techniques provide new approaches for the identification of parasite antigens. Protein antigens which are employed by different parasites for similar functions may share conserved structional regions comprising seven or more amino acid residues. This information can facilitate identification of the relevant gene(s) by PCR. A potential problem with "concealed" antigens is their low abundance in the cell or the very few cells that synthesise them. PCR methods can be used to identify rare parasite antigens which could not have been investigated using the techniques available only two years ago.

These principles will be illustrated by reference to current work involving the identification of a large family of genes encoding serine proteases from the buffalo fly and sheep blowfly. The application of similar techniques to identify other parasite antigens will also be discussed.

XVIIS-7 Potential for Vaccines Against Blood Sucking Arthropods

TICK INDUCED MODULATION OF THE HOST IMMUNE RESPONSE. THE CYTOKINE NETWORK. Stephen K. Wikel and Rangappa N. Ramachandra, Department of Entomology, Oklahoma State University, Stillwater, Oklahoma 74078, U.S.A.

Ixodid tick feeding stimulates host acquired resistance, which has an immunological basis involving antibody, complement and cell mediated immune effector pathways. Ticks introduce a variety of immunogenic and pharmacologically active substances into the host during the process of obtaining a blood meal. Some of these molecules represent tick counter measures to modulate host anti-arthropod defenses. Immunosuppression of the host facilitates tick feeding and pathogen transmission. Lymphocytes derived from tick infested hosts have diminished in vitro responsiveness to T-lymphocyte mitogens and impaired ability to develop antibodies to a thymic dependent antigen. Cytokines are critical components in regulation of the host immune system. Tick salivary gland material collected daily during the course of engorgement was assessed for its ability to alter cytokine elaboration by host macrophages and T-lymphocytes. Macrophage derived interleukin-1 was suppressed for the first six days of engorgement and tumor necrosis factor alpha was reduced for all days studied. T-lymphocyte cytokines interleukin-2 and interferon gamma were reduced. Macrophages and helper T-lymphocyte subset 1 appear to be suppressed. Immunosuppression correlated with the time when pathogens are transmitted by the feeding vector.

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STUDIES ON HOST-PARASITE IMMUNE INTERACTION INFESTATED BY IXODES SINENSIS. Zhi-gang Liu ,Jie-yi Song,Wei-dong Peng,Xiao-min Cui(Dept.of Parasitology,Jiangxi Medical College,Nanchang, Jiangxi 330006, China),Yi-qin Zhang, Wei-guo Tu,Jin-xing Yu,Jang-dong Zhou(Fengxin Sanitary and Anti-epidemic Station,Jiangxi 330000,China)

(E)This paper first reported that the immune resistance was induced in rabbits by repeated ticks (Ixodes sinensis) infestation.

This host resistance was expressed as a reduction in tick engorgement weight and in number of oviposition. The initial tick engorgement was 233.78±44.71 mg. The engorgement of the second and third infestation were reduced to 67.03±25.18 mg and 80.23±29.96 mg respectively ($P<0.001$).The first number of oviposition was 1865±485(eegs/tick).The second and third number of oviposition was 473±157 and 574±225.The rate of oviposition were decreased by 74.6% and 69.2% respectively.

The anti-tick antibody (ELISA) showed a dramatic increase OD value. The value of pre- and post-infestation was 0.08 and 0.48 respectively ($P<0.01$).PHA index of stimulation with ^{3}H-TdR lymphocyte transformation test was 48.57±31.41(immunized rabbits) and15.49±14.53 (control rabbits) $P<0.01$.Differences of skin responses between treated and control rabbits were also evident. The paper suggested that the immune resistance of rabbits, induced by I. sinensis, concern with both the host humoral immune and cellular immune.

STUDY ON CROSS IMMUNE REACTION BETWEEN IXODES SINENSIS AND HAEMAPHYSALIS BISPINOSA. Zhi-gang Liu , Jie-yi Song,Dong-ming Su (Department of Parasitology,Jiangxi Medical College,Nanchang,Jiangxi 330006,China)

(E)The first comparative study was conducted to test the cross immune reaction between sensitive rabbits by I.sinensis and H.bispinosa. When H.bispinosa feeded on the rabbits which had been attacked 3 times by I.sinensis,it's body weight increased only by 143.12±32.67mg .But when it feeded on the controlled rabbits,the body weight increased by 181.30±44.35 mg with significant difference in comparison with the former ($P<0.01$).

The homogenate of I. sinensis and H. bispinosa respectively showed 24 and 22 proteins and protein subunits in SDS-PAGE pattern.The main bands of I.sinensis were 6 and their molecular weights:142,105, 94, 66, 64 and 58 KD respectively. The main bands of H. bispanosa were 5 and their molecular weights:215,114,105, 98, 66 and 52 KD respectively.The number of proteins bands of H.bispinosa and I.sinensis were recognized by the sera of rabbits infestated by H. bispinosa and the sera of rabbits infestated by I. sinensis with Immunoblotting, the common antigen band was discovered,which is 105 KD protein band.It was concluded that the immune response in host infested by these two tick stimulates the production of antibodies which show cross immune reaction and the 105 KD protein antigen may be common antigen of the both ticks.

Immunity against *Ixodes ricinus* L.

M. Brossard, Institute of Zoology, Neuchâtel, Switzerland

Immunological relationships between rabbits or mice and *Ixodes ricinus* ticks will be presented. This tick species is economically and medically important in Europe. It transmits serious pathogens, babesia and rickettsia to domestic animals, TBE virus and *Borrelia burgdorferi* to men.

Parasites burden influences the induction phase of the immune response in rabbits. So 5 or 25 pairs of *I. ricinus* confer different level of lymphocyte proliferation. But acquired resistance against ticks is only partially different. BALB/c mice repeatedly infested by 20 nymphs *I. ricinus* do not acquire resistance. However they develop immediate and delayed cutaneous hypersensitivities.

For a better definition of the immunologically important components of acquired resistance against *I. ricinus*, rabbits have been treated with interleukin 2 (Il-2) or with cyclosporin A. Injections of Il-2 into rabbits during 5 days of a first infestation early stimulate a cutaneous delayed type hypersensitivity. Harmful effects on the tick biology are already observed at the first infestation. Treatment with Il-2 probably potentiates the induction of immune response in promoting the proliferation of protective lymphocytes.

T lymphocytes and synthesized cytokines (like Il-2) play also an important role in the effector phase of immunity against ticks as shown in treating rabbits by cyclosporin A during reinfestations. Immediate and delayed type hypersensitivities are respectively abolished or diminished and the resistance against ticks is less dramatic.

DEVELOPMENT OF RESISTANCE IN TORTOISES, GUINEA-PIGS AND GUINEA FOWLS TO LARVAE OF AMBLYOMMA BEBRAEUM AND A. MARMOREUM. **Y. TECHAV, L.J. FIELDEN** (Dept. of Biology, Medical University, Southern Africa, Medunsa 0204, South Africa)

A study of acquired resistance in tortoises, guinea-pigs and guinea-fowls to larvae of *Amblyomma hebraeum* and *A marmoreum* showed that repeated infestations of guinea-pigs resulted in a reduction of the mean weight of the engorged larvae of both species. No resistance was induced in guineafowls the natural host for larvae of both species. A small decline in the mean weight of engorged larvae was observed for both species of ticks after three successive infestaions on tortoises. The reduction in weight was more pronounced in *A. hebraeum* (14.5%) which does not naturally feed on tortoises than for *A. marmoreum* (8.4%) a common tick on this host. The occurence of acquired resistance in natural hosts is compared to that achieved in unnatural hosts is discussed.

ECDYSTEROIDS IN THE NYMPH OF THE TICK ORNITHODOROS PARKERI. Xiang-xiong Zhu (Shanghai Institute of Entomology, Academia Sinica,Shanghai 200025, China), James H. Oliver, Jr., Ellen Dotson (Institute of Arthropodology and Parasitology, Georgia Southern University, Statesboro, GA 30460, U.S.A.)

Ecdysteroid titer was low but measurable in the nymph before feeding. The ecdysteroid immunoreactive materials were located in the midgut and not in the hemolymph or carcass. The immunoreactivity was composed principally of an unknown compound more polar than 20,26-dihydroxyecdysone, which was possibly metabolite of ecdysteroids left over from the previous instar. The titer remained low from immediately after feeding until shortly before apolysis. However, a slight increase in the titer appeared shortly after feeding, which correlated with the formation of procuticle lamellae. The titer peaked during epicuticle deposition and then dropped to a low, but significant level shortly before ecdysis. Two major ecdysteroids, namely ecdysone and 20-hydroxyecdysone, were present at a time of epicuticle deposition while more than three compounds (ecdysone, 20-hydroxyecdysone, 20,26-dihydroxyecdysone as well as some unknown immunoreactive materials) were shortly before ecdysis.

THE ECDYSTEROIDS IN TICKS AND THEIR ROLE IN TICK'S DEVELOPMENT AND REPRODUCTION. Zai-jie Jiang[1], Qing Wu[1], Zi-hou Yun[2] and Wen-qing Shi[1] ([1]Department of Biology, [2]Department of Chemistry, Beijing Normal University, Beijing 100875, China)

In order to exptanate the role of ecdysteroids in development and reproduction of ticks we detected ecdysteroids titer in hemolymph, brain, ovary and whole female of Dermacentor niveus by high performance liquid chromatography (HPLC) and Radioimmunoassay (RIA). Besides, it, in eggs of various embryogenetic stages and new hatched larva of Haemaphysalis longicornis, was examined by HPLC. Ecdysteroids titer in hemolymph was peaked at the last day before ovipostion, it might be considered as a singnal of oviposition. Since the 3rd day after engorgement ecdysone and 20-hydroxyecdysone in ovary increased rapidly up to oviposition, it indicated that, ecdysteroids transferred into egg, might represent a hormone source for the embryo. Their titer in egg was increased along with the development of embryo up to hatching of larva. Ecdysteroids were possible to promote the synthesis of proteins. Their titer in hemolymph and ovary of diapausing female was lower than that of normal female. Therefore, the development of ovary of diapausing female was stagnated at the stage of vitellogenesis. Injection of small amount of 20-hydroxyecdysone (50 ng, 70 ng and 100 ng) into the diapausing one of D. niveus at the 20th--30th days after engorgement terminated her diapause, but the amount of eggs produced by her was fewer than that produced by normal female.

ANATOMY OF SYNGANGLION, STRUCTURE AND FUNCTION OF NEUROSECRETORY SYSTEM IN TICKS. Ewa Szlemdak (Department of Applied Entomology, Agricultural University of Warsaw, 02-766 Warsaw, Poland), **James H. Oliver, Jr.** (Institute of Arthropodology and Parasitology, Georgia Southern University 30460 Statesboro, Georgia, USA)

The basic arrangement of the synganglion in prostriate species is the same as in argasid and metastriate species. The synganglion shows fusion of supra and subesophageal ganglia into an integrated, single, central mass with a small protocerebral part of unknown segmentation and a larger tritocerebral part. The esophague runs through the synganglion and divides it into supraesophageal and suboesphageal parts. The supraesopageal portion contains a single protocerebrum with paired glomeruli, paired optic lobes and cheliceral ganglia,and a single stomodeal bridge. The subesophageal portion contains a centrally located network of commissures and connectives, a pair of palpal ganglia, paired olfactory lobes of the first pedal ganglia, four pairs of pedal gantlia and a singe opisthosomal ganglion.

The main differeces between various tick species include specific patterns of dorsal glomeruli, presence of optic lobes, precence of a retrocerebral organ complex and relegation of palpal ganglia to the subesophageal portion of the synganglian (implied by localization of palpal ganglia commissures). Neurosecretory cells (NSC) are a typical component of endocrine systems in ticks. NSC are distinct among rind cells due to their large size and concentration of neurosecretions in the cytoplasm.

VITELLOGENESIS WITH SPECIAL REFERENCE TO REPRODUCTIVE STRATEGIES. *Coons, L. B., R. #Rosell, N. *Sankhon, W. J. *Lamoreaux (*Biology Dept. Memphis State University, Memphis TN #Entomology Dept. University of Arizona, Tucson AZ)

The two families of ticks differ greatly in their reproductive strategies and in their temporal production of vitellogenin. Using *Dermacentor variabilis* (Say) as a model for the Ixodidae, we will present evidence for the following: The role of the fat body, midgut, and ovary in vitellogenin production; the titer of vitellogenin in the hemolymph during feeding and post feeding stages; the signal(s) associated with the initiation of vitellogenin production and the beginning of vitellogenesis. We will compare these results with vitellogenin production and vitellogenesis in the Argasidae and discuss the reproductive strategies of both families with reference to their different life histories.

EVIDENCE OF A JUVENOID IN TICKS. R. Michael Roe, Vasant L. Kallapur and Charles S. Apperson (Department of Entomology, North Carolina State University, Raleigh, North Carolina 27695-7613, U.S.A.) and Daniel E. Sonenshine (Department of Biological Sciences, Old Dominion University, Norfolk, Virginia 23529, U.S.A.)

Although the identity and functional significance of juvenoids are well established in insects, comparatively little is known about the juvenoids of ticks. Two processes are involved in the regulation of juvenile hormone (JH) in insects--biosynthesis by the corpora allata and degradation by specific enzymes. Potential *in vitro* biosynthesis of juvenoids by the synganglion of the American dog tick, *Dermacentor variabilis* (Say) and variations in JH esterase and JH epoxide hydrolase activity during nymphal and adult development of the tick were examined. Radiolabled products from the incubation of synganglia with ^{3}H-methionine co-eluted on reverse-phase HPLC with known JH standards. Specific changes in JH metabolic activity in comparison to changes in the activity of other metabolic systems were correlated with blood feeding and reproduction. Structure/activity studies with JH homologs and transition state analog inhibitors of JH esterase will be reported.

THE EFFECT OF ENVIRONMENTAL FACTORS OF DOMESTIC ANIMALS UPON THE ANTI-TICK ACTIVITY OF ENTOMOPATHOGENIC NEMATODES. M. Samish (Kimron Veterinary Inst., P.O. Box 12, Beit-Dagan 50250, Israel), I. Glazer (The Volcani Center, P.O. Box 6, Beit-Dagan 50250, Israel).

Ticks are commonly controlled by chemical acaricides. Due to the limited information on the biological enemies of ticks, no anti-tick bio-acaricides are as yet in use although they are already being applied commercially against some plant insect pests. Recently the authors found in laboratory trials that the entomopathogenic soil-borne nematodes from the families Steinernematidae and Heterorhabditidae which are obligatory arthropod parasites are highly virulent to fully engorged ticks. The most infective strain analysed, i.e. Steinernema carpocapsa 'DT' has LD_{50} and LD_{90} values of 15 and 16S IJ's/ Boophilus annulatus female respectively.

This study reports on the effect of some specific factors encountered in the living area of domestic animals upon the efficiency of these nematodes as anti-tick bio-acaricides.

Cups incubated at 28°C and open outdoor cylinders were filled with sandy soil or various concentrations of manure together with nematodes and engorged B. annulatus female ticks. Tick mortality decreased with increasing additions of various types of manure. Chicken manure seems to reduce the virulence of the nematodes more than cattle manure, horse, sheep or goat manure.

THE POTENTIAL OF MEMBRANE BOUND PROTEINS OF THE GUT OF RHIPICEPHALUS APPENDICULATUS FOR ANTI-TICK VACCINE. Essuman S. and Muteria P. Interntional Centre of Insect Physiology and Ecology (ICIPE), P.O. Box 30772, Nairobi, Kenya.

Homogenates of a variety of tick tissues have been used as experimental immunogens to induce immune protection in host animals against subsequent tick challenge as part of an overall objective of developing an anti-tick vaccine as an alternative method for tick control. Of these homogenates, that from the gut has induced a relatively better protection. We have been looking at the efficacy of detergent solubilized membrane bound proteins of the gut of the tick Rhipicephalus appendiculatus, the vector of Theileria parva, the causative agent of East Coast fever. This paper reports on the ability of the solubilized membrane bound proteins to induce protective immunity in the host (e.g. 45% reduction in engorgement weight), to augment an existing acquired immunity, and to modify the gut wall of ticks fed on animals immunized with these antigens to enhance the passage of IgG into the haemolymph (about 100% increase in IgG concentration). The approaches for the isolation and purification of immunopotent antigen(s), especially the glycoproteins which share common carbohydrate antigenic epitopes with salivary glands glyco-proteins, will be discussed.

BIOLOGICAL CONTROL OF IXODES DAMMINI, THE TICK VECTOR OF LYME IN THE NORTHEASTERN UNITED STATES: PERSPECTIVES AND ENIGMAS. Renjie Hu and Kerwin E. Hyland (Department of Zoology, University of Rhode Island, Kingston, RI 02881, USA)

We evaluated the potential of using the wasp parasitoid, Hunterellus hookeri, for reducing the population of Ixodes dammini, the tick vector of Lyme disease in the northeastern United States. In 1988 and 1989, we found that nearly 20% (n=527) of host-seeking I. dammini nymphs from Prudence Island, RI, contained wasp eggs with an average of 6±1 eggs per tick. In addition, we found only 3.5% and 5.6% engorged nymphs derived from live-captured small rodents, Peromyscus leucopus and Microtus pennsylvanicus, were parasitized, respectively. No sign of wasp parasitism was observed in engorged larvae from these animals. Even though the mechanism and effectiveness of wasp parasitism in tick control need to be further investigated, it appears that the wasp kills its tick host but only after the parasitized nymph has completed feeding and the wasp parasitism may inhibit ticks from either acquiring a host or attaching to it successfully, a process that may serve to natually regulate tick population.

THE C—BANDING AND G—BANDING AND SCANNING ELECTRON MICROSCOPY OF THE CHROMOSOME OF TICKS AND GAMASID MITES. Hong—fu Zhou, Chun—sheng Chen, Gue—sheng Li, Zhi—hui Jin, Yang—chun Meng (Department of Parasitology, Suzhou Medical College, Suzhou 215007, China)

The C—banded and/or G—banded chromosome of 4 species of ticks and 6 species of gamasid mites were studied. Analysis of these karyotypes was carried out. The submicroscopical structure of the chromosome of *Haemaphysalis japonica*, *Boophilus microplus* and *Laelaps echidninus* was visualized for the first time in Acari by scanning electron microscope. An inherent specificity of coils, which correspond to the G—bands by light microscope, was shown in the chromosome arms of *H. japonica*. It seems that the coils of the chromosome are less clear than that of human chromosome. Telocentromore have been demonstrated by C—banding in all of 3 species of ticks *Dermacentor silvarum*, *D. nuttalli* and *B. microplus*. The centromeric index of the chromosome from No. 1 to No. 3 of *Dermanyssus gallinae* is 40.5±2.1, 32.8±1.5, 16.2±1.5. So they belong to metacentric , submetacentric and subtelocentric chromosome respectively. The karyotypes of 8 species of ticks and 8 species of gamasid mites were studied in China. The endopolyploids of *Argas persicus* i.e. 4n=52 and 8n=104(96+XXXXYYYY) were found.

Key words: tick, gamasid mite, chromosome, C—and G—banding, scanning electron microscopy

VECTOR ECOLOGY FOR TSUTSUGAMUSHI DISEASE IN JAPAN: VECTORS' DISTRIBUTION PATTERN AND ASSOCIATION WITH THE PATHOGEN (ACARI, TROMBIDIFORMES). K. Uchikawa, F. Kawamori, N. Kumada (Department of Parasitology, Shinshu University School of Medicine, Matsumoto 390, Japan)

Adopting the Tullgren funnel method, we have made an ecological study of chiggers to provide information about distribution pattern of specific habitats of chigger vectors. It is proved that *Leptotrombidium pallidum* occurs predominantly on large paddy banks and sunny grasslands on abandoned farms, both of which have been increasing in area in accordance with socioeconomic changes. Recently we carried out an integrated study on distribution patterns of *L. pallidum* and *L. scutellare*, the patients and *Rickettsia tsutsugamushi*, the etiologic agent, in the patients, rodents and unfed chigger vectors in the Gotenba-Oyama District on the eastern slope of Mt. Fuji. The two chigger vectors had respective, specific habitats. The 2 vector specific strains of rickettsiae, one in *L. scutellare* and the other in *L. pallidum*, were documented. Distribution pattern of patients who harbored either of these rickettsial strains accorded well with those of the 2 chigger vectors. Seasonal fluctuation of patients was coupled with the activities of all kinds of chigger vectors, and problems to be solved in the area were pointed out. Thus, we think that our study could be a good model for the epidemiologic investigation in any endemic area of tsutsugamushi disease.

QUANTITATIVE STUDIES ON DISTRIBUTION, DAY—NIGHT AND SEASONAL VARIATION OF FOLLICLE MITES ON HUMAN FACE. Yang—chun Meng, Jian—wei Wu (Department of Parasitology, Suzhou Medical College, Suzhou 215007, China)

We have tried to use 1.2cm×5cm(6cm²) adhensive cellophane tape technique for quantitative detection of follicle mites.

In an investigation of 8 person—times , the number of mites found on various parts of the face were in the following order: upper—cheek(233), mid—cheek(153), lower—cheek(114), chin(78) , forehead(59.5), nose(55), infraorbital(54.5), paraoral(49.5), nasal groove(45), mites found on other parts being negligible.

An observation was carried out for 6 demodiciasis during 24hr. The adhensive tape was replaced in two hours' interval and the number of the mites on the tapes was counted under microscope. The variation of the mite number was significantly higher in the time from noon to midnight(12/am to next day 4/am) then in the morning(4—10/am).

Sampling the same location on the face of 12 demodiciasis by the month or the two months, we oberved the seasonal variation of the number of follicle mites. The total number is 1036. The average infestation intensity changed with season: 34.5 in spring, 22.5 in summer, 21.8 in autum , 7.4 in winter. There was the same trend as the percentage of the live mites of both species among the sum changed with season.

These results indicated the proper location, time and season for diagnosis, treatment and prevention of demodiciasis.

A DOUBLE-BLIND STUDY ON TREATMENT OF ROSACEA-LIKE DEMODICIDOSIS WITH 0.2% IVERMECTIN SOLUTION. Jian-wei Wu (Department of Parasitology, Zunyi Medical College,Zunyi 563003,China),Bi-lan Cao, Quan Zheng, Zhong-wen Shen (Department of Dermatology, Affiliated Hospital of Zunyi Medical College,Zunyi 563003,China)

Twenty-one cases with rosacea-like demodicidosis were treated with 0.2% ivermectin solution or the solution base as a placebo for one and a half months.The trial was performed double-blind, and the cases were assessed once half a month. The varieties studied were: (1) both demodex mites counts, (2) lesion counts and degree of the lesions.

In the varieties of Demodex folliculorum counts, lesion counts, and degree of the lesions,0.2% ivermectin proved to be significantly more effective than placebo. After the treatment with 0.2% ivermectin, while cutaneous lesions became improved, the number of D. folliculorum was gradually decreased. But no significant varieties were found for D. brevis.The second week (after stop of the treatment)the mites counts and lesion counts were the same as that was made at end of the treatment for 3 follow-up cases.

EVOLUTION OF MORPHOLOGICAL ADAPTATIONS OF FEATHER MITES SUPERFAMILY ANALGOIDEA (ACARINA) ON BIRDS. S.V.Mironov (Zoological institute, Russian Academy of Sciences, Sanct-Petersburg,199034,Russia,)

The feather mite superfamily Analgoidea includs 14 families accordingly recent concept. Basing on four general complexes of morphological characters, namely form of body, type of body sclerotisation, structure of body chaetom, leg structures used in moving and attachment on a host, the seven general morpho-ecological types of mites are recognised(Analgoid, Proctophyllodoid, Dermoglyphoid, Epidermoptoid, Knemidocoptoid, Laminosioptoid, Cytoditoid types). Members of each morpho-ecological types are represented by certain families of feather mites and specialised respectively to certain microhabitations on hosts, namely different types of feathers, skin, nasal and lung caves. Basing on preliminary elaborated phylogenetic scheme of the superfamily Analgoidea the hypotetic morphological evolution of these mites in processus of adaptation to different external structures of birds is proposed in general lines. It is shown that coverts and down feather as well as surface of skin were settled primarily by feather mites. Microhabitations with hard ecological conditions and well protected microhabitations were probably conquered secondarily by evolved phyletic branchs.

STUDIES ON PULMONARY ACARIASIS. Xing-bao Chen(Department of Parasitology. Bengbu Medical College. Anhui. China)

658 people who engaged with grain. traditional medicinal herbs, tobacco and textile were examined. The sputum mites of 153 people showed positive. of whom 101 cases of pulmonary acariasis were diagnosed and the incidence was 15. 35% . 16 species of the sputum mites were identified. Pured living mites were injected into the tracheae of guinea-pigs to form animal model of pulmonary acariasis. meanwhile the pathological changes of the lung tissue have been observed. and the pathogeny of five common mites were compared by injection into five groups of guinea-pigs. The pathogenic factors mainly include the mechanic injuries caused by infesting and the allergic reaction caused by soluble antigen of parasitic mites. Three immuno-diagnostic methods have been used to determined the specific antibody of the patients' sera. The potive rates of the ABC-ELISA. IHA and IFA were 82. 35% .86.49% and 90.91% respectively. The mite tissue slide as antigen was first time used in IFA. The clinical characteristics of the disease have been analysed and 5 diagnostic criteria for the disease have been put forward. Both the serum specific antibody and sputum mites positive are important for diagnosis. All the patients have been treated with metronidazole by different dosages and therapies. 95. 69% of the patients turned for negative in sputum mite examination. 58.40% are fully recovered and 31. 68% showed distinct improvement. 14 months after treatment. 67.70% of the patients were still satisfactory.

STUDIES ON NATURAL INFECTION OF EHFV IN LEPTOTROMBIDIUM (L.) SCUTELLARE AND ITS ROLE IN TRANSMISSION OF EHFV. Guang-hua Wu, Yun Zhang,Xue-zhong Zhao, Bing-gen Zhang,Yun-lung Hu, Ying-kuo Zhang, Jiang Shi (Institute of Military Medicine,Nanjing 210002, China) , Ke-jian Jiang, Geh-wei Fan, Jia-ju Zhang, Ru-he Men, Yan-ping Zhou, Yue-huai Gan, Jun-yin Qian(Institute of Preventive Medicine of Shanxi Province, Sian 710054, China)

Chigger mite has been considered to be the suspected vector of epidemic hemorrhagic fever (EHF) since the fifties of the century. In order to further elucidate the role of Leptotrombidium (L.) scutellare in transmission EHF virus, a series of studies were carried out in 1988～1990. The main results were : EHFV could be isolated from both larvae of free mites collected from grassland of endemic areas (collected with small blackboard method) and larvae of filial mites hatched in the laboratory (hatched from eggs laid by adult taken from soil of endemic areas); the suckling mice bitten by these larvae could be infected by EHFV. The above results indicated that these larvae had natural infection of EHFV and could transmit EHFV via biting. As only the larvae of trombiculid mite can bite vetebrate hosts and a full meal only in its entire life cycle, the pathogen carried by it can only be originated from its parent mite via transovarial route. As the larvae uesd in this study had never bitten, it indicated that the natural infection of EHFV in these larvae could only be transferred via transovarial transmission. These results demonstrate that: L. (L.) scutellare can naturally be infected by EHFV; EHFV can be transmitted via biting and transovarial transmission; and therefore, L. (L.) scutellare can serve as a transmitting vector of EHF.

STUDIES ON THE INORGANO-TROPHIC NICHES OF HAWTHORN SPIDER MITE, EUROPEAN RED MITE AND THEIR PREDATORS. Yu-chuan Qin, Zuo-rui Shen, Ke-xun Huang (Department of Plant Protection, Beijing Agricultural University, Beijing 100094,China)

10 inorgano-trophic elements, namely, K, P, Mo, Zn, Cu, Mn, B, Mg, Ca and Fe, detected in apple leaves collected from various positions of apple canopy, and the main movement positions of hawthorn spider mite Tetranychus viennensis Zacher, European red mite Panonychus ulmi (Koch) and their predators were investigated. The constituted data matrix was used in R-principal component- and principal axe-analyses to form the 95% equidensity probability ellipses, i.e. the inorgano-trophic niches of these populations in canonical space; and the intersection between the ellipses do be the niche overlap between populations. In consideration of the time-dimension, the expanse and contraction and center shifting of these niches were analyzed. After the screening of principal component analysis, two dimensions of components, the PC-I and PC-II, were left. PC-I, the primary one, reflected the synthetic function of various elements, and PC-II, the secondary one, reflected the main elements effecting on these populations in different stages. The similarity and differentiation among the two spider mites and their predators changed in various stages. Although the contribution rate of PC-II was much lower than PC-I, the effect of the former on the center shifting of niche was more significant than the latter.

AGISTEMUS INDUSTANI Gonzalez-Rodriguez (STIGMAEIDAE: ACARINA) AN EFFICIENT PREDATOR OF TETRANYCHUS LUDENI ZACHER ON MULBERRY. Masoud Arbabi, G.P. Agrawal and J. Singh (Department of Entomology, Banaras Hindu University, Varanasi 221005, India).

Agistemus industani mite has been identified as one of the most abundant efficient predators of Tetranychus ludeni on mulberry trees. Maximum one or two predators were often recorded on mulberry leaves during September to February months. A. industani has been observed feeding voraciously on eggs of T. ludeni. In laboratory condition the progeny of fertile female gave the female and male in 3:1 ratio. Unfertile female produced male only. The range of oviposition was 45 to 98 eggs during 20-43 days per female. The total developmental period of female predatory mite fed on egg of T. ludeni varied from 7 to 9 days whereas it was 6-8 days in case of male. The adult female longivity of this predator varied from 23 to 46 days in laboratory condition whereas in male it was 23 to 48 days. The feeding rate of female predator was three times more than male. On an average against consumption of 15 eggs of prey nearly 3 eggs of predator were deposited per day. The male predator consumed nearly 6 eggs per day. The paper also deals about the prey:predator interaction in laboratory condition.

STATUS OF PHYTOSEIID MITES FOUND ASSOCIATED WITH MAJOR PLANT FEEDING MITE PESTS IN VARANASI REGION OF UTTAR PRADESH (INDIA). J. Singh, G.P. Agrawal and Masoud Arbabi (Department of Entomology, Banaras Hindu University, Varanasi-221005, India).

A survey was conducted to know the status of common and potential phytoseiid mites found associated with major plant feeding mite pests in Varanasi region of Uttar Pradesh. Twenty species of phytoseiid mites have been identified. Amblyseius longispinosus, A.alstoniae, A. multidentatus, Phytoseius kapuri, P. minutus and P. roseus were identified as common species on different host plants. Amblyseius herbiculus, A. largoensis, A. ovalis and Typhlodromus homalli were recorded as occasional and potential predators. The regular and potential predators were Amblyseius longispinosus and A. alstoniae. Tetranychus ludeni, T. cinnabarinus, Eutetranychus orientalis, Eotetranychus hirsti, Schizotetranychus cajani, Brevipulpus phoenicis and B. californicus are considered as the major pests of different host plants in this region. Amblyseius longispinosus. is voracious feeder of egg stage of Tetranychus spp. Amblyseius herbiculus and A. largoensis are voracious feeder of all active stages of Tetranychus spp. Whereas Typhlodromus homalli feeds on all stages of Eutetranychus orientalis and E. anneckei. The paper also deals about occurrence and status of other phytoseiid mites with their prey.

THE PREDATION OF AMBLYSEIUS VULGARIS (ACARI: PHYTOSEIIDAE) TO TETRANYCHUS CINNABARINUS (ACARI: TETRANYCHIDAE) Zhimo Zhao, Yan Chen (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

The functional response and numerical response of A. vulgaris to its prey Tetranychus cinnabarinus, were studied as well as the feeding preference. A. vulgaris preferred to feed on larva of T. cinnabarinus. Selection coefficients of A. vulgaris to egg, larva. nymph and adult of T. cinnabarnus were 0.25. 2.06. 1.29 and 0.41, respectively. The functional responses of A. vulgaris to different stages of T. cinnabarinus fitted to the type of Holling II The searching efficiencies were different when they fed on different stages of the prey mite. The numerical response of A. vulgaris. When the ratio of predator to prey was 1:1-2, the oviposition rate was 0.5 eggs/ female/ day for a 10-day period; When the ratio was over 1:4, oviposition rate was 1. 95 eggs; and when the ratio was 1: 7, the oviposition rate decreased to about 1.7 eggs. This probably resulted from the fact that higher prey mite densities interfered the oviposition of the predators.

STUDIES OF THE INDUCTION OF DIAPAUSE AND THE HIBERNATION IN THE CARMINE SPIDER MITE *TETRANYCHUS CINNABARINUS*. Qian-hong Wu(Department of Environment and Resource Biology, Fudan University, , Shanghai 200433, China)

We studied some diapause characteristic of *T.cinnabarinus* (Acarina: Tetranychidae) which had been reared on bean plants in the laboratory. The diapause induction response curve was of the long-day type, showing a sharply defined critical daylength of 9hr 45min. In the daylength of 0-1.5 and 11-24 hr no diapause induction occurred, but in the daylength of 6hr 15min to 9hr 45min diapause incidence was already complete at 15°C. Although photoperiodic sensitivity was demonstrated during deutonymph and adult, sensitivity was maximal at the adult stage. Diapause induction can not happen during other instars.All developmental stages of *T.cinnabarinus* have been observed in winter time in the suburb of Shanghai. There are not diapause individuals in the hibernating female mites which were found in two colours: purple-brown and light purple. The number of light purple individuals increases with the drop of temperature. There are more individuals at quiescence stages than those at mobile stages in the coldestperiod. A few of eggs are laid by the purple-brown female at higher temperature in winter. Most of the light-purple females which were taken in suitable environment after 2-3 days laid eggs. Their overwintering hosts are chiefly *Cerastium arvenica*, *Veronica didyma*, *Pisum sativum* and so on.

ULTRASTRATRUCTURAL RESEARCH ON TETRANYCHUS CINNABARINUS (BOISDUVAL) (ACARI:TETRANYCHIDAE). Xiao-yue Hong, Yin-chang Wang and Zi-ping You (Department of Plant Protection, Nanjing Agricultural University, Jiangsu 210014, China)

The spheroid egg of carmine spider mite has 10-15 strips extending 30.59 μm on its top surface. The strip has ribs, the average rib height being 0.57 μm, the distance between two ribs being 2.65 μm. The thickness of egg shell is 0.625-1.458 mu. The egg contents include lipids, glycogen and a lot of small electron-dense particles.

There are no dorsal lobe structure on the integument folds of all stages of the female mite and adult male except the adult female whose infoldings and lobs vary according to the different body areas. The cuticle is composed of epicuticle and under procuticle. The former is differentiated into dense layer, cuticulin layer and wax layer, the latter composed of exocuticle extending to the ridges, and endocuticle whose lamella varies according to the stages, the dorsal or ventral surfaces, and the various parts of the mite. For adult female mite, the average ridge height is 0.0789 μm, and the distance between ridges is 0.158 μm. The lamella of endocuticle are 5-10, each of them being 0.10-0.15 mu thick. The chrysalis stages have high ridges and less or no lamella in endocuticle.

The sperm structure of the mite is simple, due to the condensation of the chromatin and the absence of nuclear envelope, flagellum and acrosome. Mitochondria and ribosomes are not seen. The outer membrane is 0.015-0.025 μm thick, the height and width of cuboidal invaginations of plasma membrane are 1.33-2.5 μm and 0.025-0.033 μm respectively. The diameter of mature sperm and its nucleus are 1.3-1.5 μm and 0.6-0.7 μm respectively. The spermiogenesis begins with the invagination of the plasma membrane, ends with the condensation of nucleus and cytoplasma.

QUALITATIVE COMPOSITION OF VEGETABLE MITES OF EASTERN UTTAR PRADESH (INDIA). R.N. Singh (Department of Entomology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005 INDIA)

Mite problem in agriculture, particularly in vegetable crops, has gained economic importance now-a-days. To check the mite menace and for applying better mangement practices, an affort was made by surveying various phytophagous and predatory mite species associated with vegetable crops in this area. The mites identified from different vegetable crops are mainly belonged to 3 orders. The order Prostigmata represented by 7 families, 10 genera and 20 species whereas Mesostigmata represented by 1 family, 3 genera and 5 species. The order Astigmata represented by 1 family, 1 genera and 1 specie. Of the total 26 species recorded 16 are of phytophagous nature and rest belong to predatory group. Among the 24 vegetable crops surveyed, maximum number of species were recorded on brinjal (15 species) followed by bottle-gourd and lady's finger (8 species each). Rest of the vegetable crops harboured (1-6) species. Out of the 26 species of mites recorded one specie was new to science named as Typhlodromus (Typhloctonus) malviyai.

BIOLOGY OF SUGAR CANE MITE OLIGONYCHUS SACCHARI (MCG.) IN KHUZESTAN, IRAN.
H. Sadeghi Namaghi & K.Kamali , College of Agriculture, Shahid Chamran University. Ahwaz - IRAN.

Biology of sugar cane mite O.sacchari was studied under both laboratory and field conditions. In laboratory, at temperatures 25±1,32±1 c,70±5% R.H. and 12 h.L.D. developmental period of a generation was accomplished within 12.87 and 9.3 days respectively. Under the same conditions, average number of eggs laid per female were 76(4 a day)and 59(2.8 a day) respectively.In the sugar cane fields of Haft-Tappehand Shushtar,O.sacchari was found to be active on the lower surface of the leaves from early June to mid-September,feeding injuries initiated by producing tiny chlorosis which gradually appeared as brown spots causing leaf margins and tips to dry.Early infestation was observed at the field margins which gradually extended to the fields.Mite population initiated to build up by early June in the studied areas. Maximum population was observed in late July which gradually decreased by mid-September.Studies on percent eggs hatch of O.sacchari revealed that 78% of progenies were female,while the remaining 22% emerged as males.During its life span each male mated with 4-5 females.Parthenogenesis arrhenotoky was also observed, resulted in the all male off spring. In the field condition O.Sacchari overwintered as adult female in low density on young sugar cane plants,on weeds,especially on Bermuda grass, Imperata sp. and in the soil.

ATTRACTANCY OF FUSARIUM FUNGI FOR TWO SPECIES OF BULB MITES, RHIZOGLYPHUS ROBINI AND CALOGLYPHUS SP. (ACARI:ACARIDAE).
Kimiko Okabe (Kyushu Reseach Center, Forestry and Forest Products Research Institute, Kurokami, Kumamoto 860, Japan)

Bulb mites are cosmopolitan species with a world-wide distribution. In Japan, we have at least three genera of bulb mites, which include genera of Rhizoglyphus and Caloglyphus. These bulb mites prefered Fusarium-infected Rakkyo (Allium chinense) bulbs than healthy ones. Rhizoglyphus robini (Robine bulb mite) was attracted well to filtrates of the Fusarium culture. Filtrates were isolated and thier chemical components were identified by GC-MS analysis. Results showed that the extract mainly consisted of ethanol, n-propanol, iso-butanol, 2-methyl-1-butanol, iso-pentanol and 2-phenylethanol. Generally, Robine bulb mites were well attracted to these alcohols, alone or mixed. Even in the sand, they were also attracted to these alcohols and their attractancy was enhanced by pouring mixed alcohols on healthy rakkyo bulbs.

BIOLOGY OF BULB MITE RHIZOGLYPHUS ROBINI (CLAPAREDE) (ACARI : ACARIDAE)ON SAFFRON BULB,ONION AND POTATO TUBERS IN KHORASAN, IRAN.
HASSAN RAHIMI & KARIM KAMALI, COLLEGE OF AGRICULTURE, SHAHID CHAMRAN UNIVERSITY, AHWAZ, IRAN.

The bulb mite R. robini is a soil inhabitant mite attacking saffron Crocus sativus L. bulb in Gonabad and Ghayen, two main saffron growing areas of Southwest Khorasan, Iran. Feeding injuries resulted in secondary infestation by the soil fungi and decayed bulbs. Investigation on the field conditions revealed that R.robini can produce several generations throughout the year. Since the optimal conditions for activity of the mite were only provided during spring and autumn, thus it reproduced in high densities during these seasons. Mite population was greatly reduced during winter and summer seasons, because of intense cold and dryness of the soil respectively. The biology of R. robini was studied in the laboratory conditions under absolute darkness, 70±5% R.H., 25±1° C & 21+1° C on the saffron bulb, onion and potato tuber. It was also studied under 12 hours of darkness with 12h. illumination, %70±5 R.H., and 25±1 °C on saffron. Under total darkness and 25±1°C the developmental stages were completed within 13.75, 15.12 and 17.57 days on above mentioned substrates respectively, whereas at 21±1 °C they accomplished in 23.31, 24.33 and 29 days respectively. Under 25±1°C with 12h. L.D. the life cycle of a generation was completed within 15.81 days on saffron bulb.

#1
A STUDY ON THE SPERMATOZOA OF VARIOUS SPECIES OF TICKS IN CHINA. Gui-lan Dou (The Institute of Epidemiology an Microbiology, The Chinese Academy of Preventive Medicine, Beijing 102206, China)

The author used a technique of cell culture to preserve the spermatozoa of four species of ticks, and observed those of 6 species by direct microscopy, which were from 6 genera of 2 families in Ixodoidea. We observed the morphology of the spermatozoa in all species, on locomotion and longivity in some of them, and undertook a comparison between the families, the genera and the species as well. We found the main difference between the spermatoza of Ixodidae and Argasidae, the latter appeared longer, and thicker, whereas that of Ixodidae appeared shorter and thinner. The head and the tail of the spermatozoa appeared clear in the two families with the exception of the species in the genus Haemaphsalis.

The spermatozoa in different genera of Ixodidae appeared different in their length. The spermatozoa of different species in the same genus showed the type in common.

Our research on the spermatozoa of ticks appeared helpful for understanding their morphological characteristics, in the classification of ticks and in a study of their relationships, since the study seems to lay the fundation for distinguishing different type of the ticks' spermatozoa.

#2
STUDY ON THE STRUCTURE AND ACTIVITY OF THE NEUROSECRETORY CELLS IN DERMACENTOR NIVEUS. Zai-jie Jiang, Xiao ling Tang (Department of Biology, Beijing Normal University, Beijing 100875, China)

The neurosecretory cells are located in the cortex of the syngangtion in Dermacentor niveus. They have a low nucleus/cytoplasm ratio. In the cytoplasm the numerous electro-dense granules, well-developed Golgi apparatus and endoplasmic reticulum indicate higher neurosecretory activity. In the normal female the neurosecretory activity is peaked at the second day after engorgement, and is probably related to the beginning of the 2nd continuous digestion stage. The granules with a diameter of 130--140 nm are produced by neurosecretory cells at the 4th day after engorgement. It is connected with oviposition. Their activity is decreased abruptly up to oviposition. In diapausing female the neurosecretory activity rapidly reaches the highest level at the 2nd day after engorgement and may be maintained at least for 35 days. The large granules with a diameter of 160- 170 nm reproduced by the neurosecretory cells from the 10th day after engorgement to oviposition are possible related to keeping of diapause. During the preceding 30 days the neurosecretory activity is related to the rough endoplasmic reticulum and Golgi apparatus. The largest granules with a diameter of 220--230 nm produced at 85th day after engorgement are probably connected with the relieve of diapause. But during this time the high neurosecretory activity is related to the smooth endoplasmic reticulum.

#3
SURVEY ON TICK VECTORS OF LYME DISEASE SPIROCHETES IN CHINA. Zhefu Zhang, Guilan Dou, Jinsheng Zhang, Kanglin Wan, Guifeng Zhu, Li Zheng (Institute of Epidemiology and Microbiology, Chinese Academy of Preventive Medicine, Beijing 102206, China)

Since 1987, we have been studing on Lyme borreliosis in China. There were 63 isolates of Borrelia burgdorferi recovered from Ixodes and Haemaphysalis, and 50 isolates from Ixodes persulcatus collected by flagging in the northeast and northwest. Ixodes persulcatus is the dominant species accounted for more than 80% of the total number of collected ticks. 40 or 45 per cent adult Ixodes persulcatus contained spirochetes as determined by direct immunofluorescence. These results proved that Ixodes persulcatus played the leading role in transmission of Borrelia burgdorferi in the north of China. It is not clear what tick is the principal vector in the south of China, though the spirochetal isolates were cultivated from Ixodes granulatus and Haemaphysalis bispinosa. Comparison between the Chinese strains of spirochetes from ticks and American strain B31 in monoclonal antibodies reaction and ultrastructure revealed certain differences.

#4
ASPECTS OF THE COMPARED IMMUNOPATHOLOGY IN DOGS, HAMSTERS AND GUINEA-PIGS TO *Rhipicephalus sanguineus* TICK (LATREILLE, 1806). Bechara, Gervásio Henrique, M.P.J. Szabó, L.S. Mukai, P.C.S. Rosa (Faculdade de Ciências Agrárias e Veterinárias, UNESP, 14.870-Jaboticabal,SP Brasil)

The aim of this work was to study immunopathological aspects of acquired resistance to *R. sanguineus* tick in its natural host, the dog and comparatively in hamsters and guinea-pigs. For this purpose, tick-bite naive experimental groups of these hosts, were either infested three times or inocculated three times with unfed adult extract of the tick and then challenged with an infestation. The acquisition of resistance was based upon variations of biological parameters of female ticks, anatomo-pathological analysis of the injury at the tick feeding site, host behavior and antigen recognition capacity by host antibodies according to the treatment. The results showed an absence of resistance in the dog to *R. sanguineus* ticks in these experimental conditions. Hamsters and mainly guinea-pigs developed quite an efficient immunity to this tick in al the situations. Differences were observed between resistance induced by infestations or vaccination.

#5
THE SEASONAL DISTRIBUTION AND SEXUAL RATIO OF *HAEMAPHYSALIS LONGICORNIS* NEUMANN. Yun-zhong Shen, Jun-ping Zhao, Yuan-xian Li, Guo-qi Zhang (Department of Parasitology, The Fourth Military Medical University, Xi'an 710032, China)

Haemaphysalis longicornis Neumann is not only a peregrinus or cosmopolitan pest, but also a dominant species in some regions sometimes. The seasonal distribution and reproductive biology were studied by many scientists, however, it requires a great deal of further researches in the above areas. The seasonal distribution and bisexul ratio of *H. longicornis* were surveyed from 1982 to 1983 in the regions of Nanniwan and Huanglong Mountains, Shaanxi Province. The results were as follows:

(1) The period of the seasonal distribution abundance of the adults of *H. longicornis* on the hares is from April to August. In the middle of May, the papulation starts to increase and the time decreased markly is in the middle of July. In the last ten days of July, the seasonal distribution curve has three peaks. Only a few adults are seen on hares in the middle of August.

The bisexual seasonal distribution curves are parallel with each other, however the male seasonal distribution curve in the parasitie index is over twice higher than that of the female from beginning to end.

(2) The bisexul ratio of *H. longicornis* is male: female = 2.28: 1.00 ($X^2 > X^2_{0.01}$), it indicates that the bisexual ratio is very different between the males and females; so that we thought it is bisexual population; however we do not think both of parthenogenetic and bisexual populations in the regions of Nanniwan and Huanglong Mountains.

#6
HARES AND HARE-PARASITIZING IXODID TICKS. Yun-zhong Shen, Jun-ping Zhao, Yuan-xian Li, Guo-qi Zhang (Department of Parasitology, The Fourth Military Medical University, Xi'an 710032, China)

A survey was carried out from 1982 to 1983 in the regions of Nanniwan (alt. 1200-1459m) and Huanglong Mountain (alt. 1500-1783m), Shaanxi, 408 hares (*Lepus capensis* Linnaeus) were examined for the presence of ixodid ticks. The infestation rate was 100%. The abundance index of ixodid ticks was 29.77 per animal. A total of 11942 ixodid specimens were collected, they belonged to 6 genera, and its construction as follows: *Haemaphysalis* Koch, 90.86%; *Dermacentor* Koch, 6.19%; *Hyalomma* Koch, 1.89%; *Rhipicephalus* Koch, 0.91%; *Ixodes* Latreillis, 0.06% and *Boophilus* Curtice, 0.09%. The population index and the population structure of adult ixodid ticks were recorded as follows: *H. longicornis* Neumann, 13.27, 96.05%; *H. japonica* Warburton, 0.14, 1.01%; *H. yeni* Toumanoff, 0.01, 0.05%; *D. Kabaensis* Teng, 0.002%, 0.02%; *D. marginatus* Sulzer, 0.28, 2.05%; *D. niveus* Nemmann, 0.05, 0.04%; *D. silvarum* Olenev, 0.01, 0.05%; *D. sinicus* Sehulze, 0.09, 0.64; *Hyalomma dromedarii* Koch, 0.002, 0.02%; *Boophilus* sp., 0.002, 0.02% and *Ixodes* sp., 0.01, 0.05%. It was illustrated that *H. longicornis* was a dominant species of these ixodid ticks.

A large number of the recent scientific treatises in this area lead us to believe that the all active stages of most species of these ixodid ticks were the vectors of zoonosis; and some of the pathogens might transmite by trans-ovarial or trans-stadial infection of ixodid ticks.

#7
THREE NEW SPECIES AND A NEW RECORD OF VULGAROGAMASUS FROM CHINA (ACARI: PARASITIDAE).
Yi-ming Gu (Medical School, Nanjing University, 210008, China), Huang Chung-an (Shaanxi Sanitary and Anti-Epidemic Station, Xian, 710054, China).

The present paper deals with three new species and one new record of the genus Vulgarogamasus from Shaanxi Province, China. Type specimens are deposited in Shaanxi Sanitary and Anti-Epidemic Station.

1. Vulgarogamasus oligochaetus sp. nov. collected in nest of bird. only 2 pairs of sternal setae, St3 and MST absent; with particular shaped tectum; and inner side of peritreme bearing denticles.

2. Vulgarogamasus multisetus sp. nov. collected in nest of Cricetus triton, bearing 34 setal pairs on podonotal plate and 54 setal pairs on opisthonotal plate, two times more than general.

3. Vulgarogamasus palmatus sp. nov. collected in cave of Ochotona thibetana, is near to the former new species, V. multisetus, the differences are: idiosoma smaller; dorsal setae lesser; with a spine on the basal portion of palp femur; a crest on trochanter IV, and a long seta on tarsus IV.

4. Vulgargamasus remberti (Oudemansi, 1912) The first record in China. It collected off Cricetus triton.

#8
ETTES OF THE HAEMOGAMASIDAE IN CHINA WITH DESCRIPTION OF A NEW GENUS (ACARI: PARASITIFORMES) .
Man-shu Zhou (Sichuan Sanitation and Anti-Epidemic Station, Chengdu 610031, China), Yi-ming Gu (Nanjing University Medical School), Ting-huan Wen (Shanghai Medical University), Jusheng Wang (Guiyang Medical college)

This paper records fifty three species and subspecies of the Haemogamasidae in China with description of a new genus Terasterna.

The new genus Terasterna is established with T. emeiensis (Zhou, 1981) as the type. The new genus Terasterna was formerly separated from Emeiensis-group of Haemogamasus.

Terasterna gen. nov.

Generic diagnosis: Sternal plate without posterolateral projection, median-lateral projection incomplete; peritrematal canal short; chela ladle-like. These can be obviously distinguished from the other species in the genus Haemogamasus. The type species of the new are preserved in the Sichuan Sanitation and Anti-Epidemic Station .

#9
STUDY ON GENERATIVE CHARACTERISTICS OF TROPILAELAPS CLAREAE DELFINADO ET BAKER (ACARI: LAELAPIDAE).
Hua-zhen Wei(Institute of Honey Bee Research, Chinese Academy of Agricultural Sciences, Beijing, China)

Matting and laying eggs of temale and male mites take place in a sealed cell. The female mite starts to lay eggs 48 to 52 hours after the cells have been capped. The most eggs are laid between 100 and 110 hours after that time. Female mite can produce one to six eggs, usually one to three. The six-legged larvae hatch 15 to 30 minutes after the eggs have been laid. Then, they develop to eight-legged protonymphs after a further 20 to 24 hours. They moult within 44 to 48 hours becoming deutonymphs and grow up to imagines after another 48 to 52 hours. It needs 4.7-5 days from egg to adult mite. Generally, the first egg of female mite developed intoa new female mite, and the second egg developed into a new male mite. The ratio of female to male was 2.4:1.

#10
NUMERICAL TAXONOMY OF THE SUBGENUS GAHRLIEPIA (ACARIFORMES: TROMBICULIDAE).
Yan-yun Gui, Ting-huan Wen (Shanghai Medical University Medical Acarology Laboratory, Shanghai 200032, China)

In the genus Gahrliepia of Walchiinae the type subgenus Gahrliepia is characterized by the scutum large tongue-shaped, with wide SB, punctae (pc), maculae (mc), scrobiculae (Scr), and 4 or more post-posterolateral setae (PPL). In some of the species the PL moved far anteriorward and adjecent to AL, they appear to be two pairs of ALs.

To date there are 80 named species of the subgenus, of which 34 were recorded in China including a species sharing distribution in other country, and 46 are the allopatrics. According to the specimen collections and literature available 83 species (including 9 new species and 1 new subspecies) each with same 20 selected characters and measurements were undergone for the cluster analysis.

Two dBASE numerical banks had been built. The first one includes 10 species and subspecies with PL moved anteriad either before the SB or in a line with it. The second one composed of 73 species with PL posterior to the SB level normally. Only 1 method of cluster analysis was used with the first numerical bank, the result was satisfied and in accordance with the morphological affinity among those species. For the second bank 10 tests were conducted by 10 ways of cluster analysis using difference unity of measurements and cluster methods in order to select the best classification. The results showed that only slight variations between different ways and the third method(measure: seuclid, method: waverage) is the best one. Accordingly 4 groups were differentiated: (1) the species with pc and Scr ; (2) nonscrobiculate species, PPL= 8-17; (3) nonscrobiculate species, PPL= 4-8;(4) nonscrobiculate species, PPL= 16-30, all measurements of the scutum large.

#11
THE DISTRIBUTION AND GEOGRAPHICAL DIVITION OF CHIGGER MITES IN JIANGXI PROVINCE,CHINA.
Jiao-biao Wang, Jie-yi Song,Wei-dong Peng, Xiao-ming Cui (Department of Parasitology, Jiangxi Medical College, Nanchang, 330006, China)

An investigation of chigger mites of Jiangxi Province is reported. 34 representatives of different districts have been investigated during the recent 11 years. From various animal hosts, 6807 specimens of chigger mites belonging to 2 families, 3 subfamilies,19 genra and 52 species were collected. Of the 2237 rodents involving 15 species examined for over 11 years,1277 were found carrying mires(57.09%).Other animal investigated were 25 of AVES with 13 positive (52.00%), 111 of Chiroptera with 32 positive (28.83%). Based on the distribution of chigger mites and their hosts, the fauna of chigger mites of Jiangxi Province may belong to the central China district of the Oriental realm. According to the data from geography, meteorology, zoology and botany of the whole Province, combining with the species and distribution of known animal host (rodents), the chigger mites of the Jiangxi Province can be divided into 2 geographical districts: I. the north district of central Jiangxi and II.the south district.The former can be farther divided into 4 subdistricts.

#12
FURTHER STUDIES ON THE VARIATIONS OF SCUTUM IN NEOSCHÖNGASTIA GALLINARUM HATORI, 1920 (ACARIFORMES : TROMBICULIDAE).
Ming-hua qiu (Ming-hwa Jeu) (Department of Parasitology, Zhejiang Medical University, Hangzhou, Zhejiang 310006, China)

The present study is based upon the observations on the materials of larvae and laboratory reared nymphs of Neoschöngastia gallinarum collected from various localities throughout the country. Further studies on the types of variations of scutal setae in the larvae and the corresponding variations in the laboratory reared nymphs were carried out. Variations and related problems were described and discussed.

Variations of scutal setae are complicated and are of various types. Aside from the two sensillae, variations of the scutal setae may be grouped into ten types: OAM, 2AM, 3AM, 2LAL, 2RAL, ORAL, OLPL, ORPL, $\frac{2AM}{2RAD}$ and $\frac{2RAL}{ORPL}$. Out of 4692 larvae examined, the percentage of variations is 0.59% ; 2AM type is the highest, being 50% . The results of laboratory reared 2AM larvae transformed into 2tch nymphs. Variations of scutal setae of nymphs occured, but standard measurements of scutum remained unchanged. 2AM type of variation is more stable and is probably inheritable. The possibility of using it as a subspecies character is discussed.

#13
INTESTINAL ACARIASIS IN CHINA. Chao-pin Li (Dept. of Parasitology, East-China Coal Medical College, Huainan 232001, Anhui, China)

1548 adults and 1596 pupils were examined for the possible existence of intestinal acariasis. 79 adult cases (5.10%), including 51 cases (3.29%) together with infection of other intestinal parasites and 28 cases (1.81%) with infection of mites only, and 98 pupil cases (6.14%), including 63 cases (3.95%) together with infection of other intestinal parasites and 35 cases (2.19%) with infection of mites only, were found positive for mites in their faeces. 7 species of mites were detected in the faeces of 177 sufferers, i.e., Acarus Siro, Tyrophagus putresentiae, Dermatophagoidae farinae, D. pteionyssinus, Glycyphagus domesticus, Carpoglyphus lactis, and Tarsonemus granarius. 49 out of 63 sufferers with infection of mites only developed marked eosinaphilia ranging from 4-11% and a count of $0.32x10^9$/L-$0.78x10^9$/L. The symtoms present were abdominal pain, diarrhoea, loose stool with mucus, burning anus, lack of strength and vigour, emaciated, etc. The findings justify that oral administration of metronidazole proves a satisfactory curative against acariasis.

#14
PULMONARY ACARIASIS IN CHINA. Chao-pin Li (Dept. of Parasitology, East-China Coal Medical College, Huainan 232001, Anhui, China)

924 subjects working in grain- or herb-storing from different parts of Anhui Province were examined for the possible existence of pulmonary acariasis. 49 cases (5.3%) were found positive for mites in their sputum. Meanwhile the speciality IgG of 32 cases of the acariasis was examined by SPA-ELISA. The eminently sucessful and often dramatic response of the disease to metronidazole is now well established. 10 species of mites were detected in the sputum of the 49 sufferers. An EM scanning observation on the external morphology of mites of 4 species causing the disease was carried out to make a detailed study of the fine structures of the gnathosoma and podosoma. The pathological study of the acariasis was performed using guinea pigs as an animal model. It has been found through pathological histological study that the main characteristics of the pathological change of the guinea pigs' lungs were bronchiolitis and peribronchiolitis. The EM morphologic observations of the acariasis and the pathological change of animals' lung tissue indicate that the pathogenic mechanism of this disease may be divided into 2 processes: the acute inflammation (tissue pathological change) caused by the acariasis which destroys the lung tissue and the immunopathological course by the allergic reaction.

#15
RESEARCH ON INTERNAL STRUCTURE, HISTOCHEMISTRY, ULTRASTRUCTURE AND PATHOGENICITY OF SARCOPTIC SCABIEI. Pei-fang Fan, Ke-qiang Chen, Ya-jun Liu, Ya-ling Pan(Shanghai Agricultural College, Shanghai 201101, China)

Ultrastructure of the body surface in each stage of Sarcoptic scabiei were observed by scanning electron microscope. It was found at first the new ultrastructure of the papillae of palp and the hypostome of three lobes in each stage.

The internal ultrastructure of the cuticle, gnathosoma, digestive system, reproductive system, muscular system and nervous system of the female S. scabiei was observed systematically for the first time by Transmission electron microscope. The distribution of biochemical material in the female was examined by histochemical study.

LM & TEM examination showed the pathological change of the epidermis and dermis in the rabbit.

#16
RESEARCH ON ULTRASTRUCTURE, HISTOCHEMISTRY AND PATHOGENICITY OF DEMODEX CAPRAE. Pei-fang Fan, Ming-zhong Ye, Ya-jun Liu, Ya-ling Pan (Shanghai Agricultural College, Shanghai 201101, China)

Ultrastructure of the body surface in each stage of Demodex caprae was observed by SEM. Ultrastructural change of the supra coxal spine, hypostome, cheliceral, and claw of palp was described systematically for the first time. It was found at first the new ultrastructure of the papillae of palp (male: 2 couples; female: 1 couples), phallomeres of 3 lobes and the boatlike vulval valve in adult. The internal ultrastructure of the cuticle, gnathosoma, digestive system, proctodeum and reproductive systme of the female D. caprae was observed by TEM. The distribution of biochemical material in the female by histochemical study.

LM showed the main pathological changes were hyperemia and infiltration of inflammatory cells in pericapillary and dermis. The fibers decreased in various degree. TEM showed no obvious change in epidermis. The degenerated basement membrane and hyperplasis of melanocytes were found after the middle or serious in festation. The macrophages, lymphocytes, monocytes and basophil were found in dermis with the various degree of infestation. The infiltration was found in the pericapillary and nervous fibers.

#17
APPLICATION OF A NEW AGENT AGAINST SARCOPTES. Jun-hua Liu, Fang-sen Wang, Wen-qi Dong, En-gui Suan (Institute of veterinary Science, Changchun Veterinary College, Changchun 130012, China)

Chemotherapeutic agents available are presently not totally satisfactory for the treatment of human scabies and animal manges. There is an obvious need for alternative acaricides. In this study, Miemanlin, a substance derived from orange peels, was tested. By washing or poured onto ears, 91% (191/196) of human cases and 99% (1487/1499) of rabbit cases were cured. By dipping, 90.9% of affected sheep were cured. No side-effects were found. In vitro tests showed that 15/15 parasites were killed in ten minutes by this agent while 10/31 by phoxin and other acarcidal preparations at the same time. The results suggest that Miemanlin is a highly effective acaricide. In addition, experimental tests showed that Miemanlin could kill some plant insects. Due to no problems of enviromental pollution, this agent is a potential insecticide for agriculture.

#18
TAXONOMY AND UTILIZATION OF PHYTOSEIID IN CHINA. Weinan Wu (Guangdong Entomological institute, Guangzhou, 510260, China)

Phytoseiid mites are the most effective enemies of phytophagous mites. In mainland of China, research on its taxonomy and utilization began in 1974, but at that time only 1 species was known in Sichuan. Now it has been found that 3 subfamies, 225 species, based on the author's collections and distribution records, they are:84 species of Phytoseiinae, 136 species of Amblyseiinae, 5 species of Chantiinae, Among them 148 new species are identified by Chinese scientists, 63 species are common with other countries, 10 species are new synonymy. The author also researched on some crop plants' phytoseiid fauna 34 species occur on citrus orchards, 14 on lychee, 10 in paddy field and apple orchards respectively. Euesius nicholsi (Ehara et Lee), Amblyseius eharai, A. newsami (Evans) are used to control citrus spider mites, A. orientalis to control citrus and apple pests, A. pseudolongispinosus for vegetables, cotton. Their biology, mass rearing, alternative food and utilization have been investigated. Thyphlodromus occidentalis and Phytoseiulus persimilis have been introduced into China. The former has established population in apple orcherds and spreaded to neighbor areas in Northwest China. The latter is used to control the spider mites in vegetables and flower.

#19
STUDY ON THE VARIATION OF COMMUNITY STRUCTURES OF SOIL ACARIDS UNDER DIFFERENT FERTILIZER CONDITIONS. Dun-xiao Hu, Yun-long Xia (Department of Plant Protection, Beijing Agricultural University, Beijing 100094,China), Shan-mei Wu (Department of Pedology and Chemistry, Nanjing Agricultural University, Nanjing 210014,China)

In 1990, the difference between the community structures of soil acarids in two vegetable fields with different fertilization was studied in Corvallis, Oregon, U.S.A.. The results showed that: 1. In organic fertilizer soil (CFS), the occurrence of Mesostigmata mites was more stable in different seasons, while in chemical fertilizer soil (CFS), there were two occurrence peaks of Astigmata mites in whole year. The occurrence of Prostigmata mites showed one obvious peak in whole year both in OFS and CFS. 2. The whole year richness of soil acarid community in OFS was higher than that in CFS. The fluctuation of diversity, richness and eveness of soil mites in CFS was higher than that in OFS. 3. The main factors affecting on the diversity of soil mites in OFS and CFS were Mesostigmata mites and Astigmata mites, respectively. There were more successive relationships among the four suborders of soil mites in OFS than that in CFS. 4. In OFS, there were more predaceous mites and nematophagous mites; while in CFS, there were more fungivorous mites.

#20
DEVELOPMENT AND REPRODUCTION OF AMBLYSEIUS VULGARIS (ACARI:PHYTOSEIIDAE) ON DIFFERENT FOODS. Zhimo Zhao, Yan Chen (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

The developmental duration, fecundity and progeny sex ratio of A. vulganis were studied on five different foods or food combinations: 1. pollen of Luffa cylindriea (L.c.); 2. all life stages of Panonychus citri (P.c); 3, all life stages of Tetranychus cinabarinus (T. c.); 4. L. c.+P. c.; & 5.L.c+T.c.. The population life table of A. vulgaris on above five different foods were also constructed. The results showed that the development of the mite was faster, both fecundity and female sex retio wer higher when they were fed on L.c. or any food combinations containing L. c than those fed on P. c. or T. c. alone. In the former case, the intrinsic rate of natural increase (r_m) was 0.209-0.259, net reproduction rate (Ro) was 18.918-35.771 and mean generation time between 15.295-19.527 days for the female adult mites. In the later case, feeding on P. c. or T. c. alone, r_m of the mite was 0. 165 and 0. 191, respectively, and Ro was 7.091 and 17. 113, respectively. The mortality was highest when they were fed on P.c. alone, and the death mainly occurred in nymph, especially in protonymph. suitabilities of different plant pollens for the mith were also studied. A. vulgaris completed its development and ovioposition when fed on the pollens of L. cylindriea, Codonopsis pilosula, Budelleis asiatica, Fagapyrum esculertum, Zea mays and Astragalus mililotoides. Whereas fed on pollens of Brassica compestris, Helianthus annaus, Quercus acutissima, Citrullus lanatus and Leonurus japonicus, it did not oviposite even though it completed development from egg to adult. It is concluded that the pollen of L. cylindriea was the most suitable food for rearing A. vulgaris.

#21
A STUDY ON PROTECTING AND USING *Ambyseius Nicholsi* IN THE INTEGRATED CONTROL OF *Panonychus Citri* **Ba-lian Zhong** (Jiangxi Navel Orange Farm, Xinfeng 341608, China)

A. nicholsi is an effective natural enemy of *P. citri*. The measures of its integrated control were: growing *Glycine max* between the citrus rows and *Ageratum conyzoicles* L and *Perilla frutescens* L etc between the plants to serve as the shifting hosts for the preying mites, to cover the ground, and regulate the temperature benefiting the growth of the citrus and the reproduction and life of the preying mites; releasing or assisting the shift of the preying mites during the occurenec period of the injurious mites according to the pest situation; not spraying pesticide on the soybeans and other crops between the citrus rows and plants when controlling the pests in the citrus trees so as to protect the preying mites in them, which would be the major resource of preying mites. This method can compromise the contradictions between biological and chemical controls. As a result, in the 3,000 mu-orchard under integrated control, the injurious mite population was controlled below the allowable level at the view point of economic indexes, satisfactory economic, ecological and social benefits were obtained.

#22
USE OF SIMULATION MODELS FOR STUDYING FACTORS THAT CONTRIBUTE TO PERSISTENCE OF MITE PREDATOR-PREY SYSTEMS. J. P. Nyrop. (New York State Agricultural Experiment Station, Cornell Univ., Geneva, NY 14456, USA)

The persistence of the European red mite *Panonychus ulmi* (Koch) and its predator, *Typhlodromus pyri* Scheuten was studied emperically at two geographic locations and at two spatial scales. At the scale of an orchard, both *P. ulmi* and *T. pyri* were persistent over the time frame of 6 years. At the scale of an individual tree, *T. pyri* appeared to be more persistent than its prey, *P. ulmi*. A simulation model of single populations of *P. ulmi* and *T. pyri* was used to determine which of several aspects of the biology of the two species could contribute to such a pattern. Spatial incongruity between predator and prey was essential for persistence of both species. The generalist food habit of *T. pyri* probably contributes to the persistence of *T. pyri* on individual trees, and may cause occasional extinction of *P. ulmi* at this spatial scale. The presence of alternate food is likely an essential element for successful biological control in this system. Cannibalism by *T. pyri* results in higher prey densities, that is, it is detrimental to the biological control of *P. ulmi*, but has no effect on the relative persistence of the two species.

#23
A STUDY ON THE INTEGRATED CONTROL OF LEAF MITES(*Tetrangchus kanzawai* Kishida) IN VEGETABLS BY USING PREYING MITES (*Phytoseiulus persimilis* A-H). **Zi-qi Yang** (Jiangxi Agricultural University, Nanchang 330045, China) et al

Satisfactory results were a chieved in the integrated control of 6 species of *Tetranychus kanzawai* Kishida in vegetables by using *Phytoseiulus persimilis* A.-H. The following integrates measures were taken: weeding in early spring and spraying pesticide to control the overwintering leaf mites and aphids, releasing the preying mites in the seed beds to prevent the seedlings from carrying pests; releasing the preying mites in the field in the beginning stage of the occurrence of the leaf mites, re-releasing the preying mites according to the pest situation if the preying mites were washed away by heavy rain or it was just before the flourishing stage of the reproduction of the leaf mites. The experimental results showed that the integrated control or biological control techniques can control the leaf mite population density below the allowable level at the view point of economic value. Therefore the times of pesticide application and the accumulation of remaining poison are reduced, the balance of beneficial and injurious insects is kept, hence satisfactory results.

#24
NUCLEAR-CYTOPLASMIC INTERACTIONS CONCERNING TO REPRODUCTIVE INCOMPATIBILITY OF *TETRANYCHUS QUERCIVORUS*. Tetsuo Gotoh and Hiroyuki Oku (Lab. of Appl. Entomol. & Zool., Faculty of Agriculture, Ibaraki University, Ami, Ibaraki 300-03, Japan)

The spider mite, *Tetranychus quercivorus* Ehara et Gotoh (Acari), is found only on deciduous oaks, and reproductive incompatibility has been found in crosses between two populatins derived from Sapporo (43°N) in Hokkaido and Tsukuba (36°N) in Ibaraki. The purpose of this study was to determine genetic factors responsible to the reproductive incompatibility. Crossing between females of the Sapporo population and males of the Tsukuba population resulted in a much lower egg hatchability and an extremely lower sex ratio than the reciprocal cross. Fertilized eggs destined to become females were dead in the late embryonic stage. After such crosses and backcrosses were continued for 6 generations, we concluded that the incompatibility could be due to interactions between the egg cytoplasm of the Sapporo population and the sperm nucleus of the Tsukuba population.

#25

MONITOR FOR RESISTANCE OF COTTON SPIDER MITES TO THREE PESTICIDES. Yu Cao (Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094, China)

The toxic reactions of carmine spider mites Tetranychus cinnabarinus (Boisduval) and T. truncatus Ehara, collected from cotton plants in the suburb of Xinxiang City, Henan Province, where chemical control has been adopted for years; and maize plants and weeds in Ningxia Hui Autonomous Region, where nearly no pesticide has been used, to dicofol, monocrotophos and omethoate were tested in laboratory. The results showed that as compared with the sensitive populations from Ningxia, both the two mite species populations from Xinxiang were obviously resistant to dicofol and monocrotophos but sensitive to omethoate. While in the same area, the LC_{50}s of T. truncatus to the three chemicals were more higher than those of T. cinnabarinus. Since under natural conditions of Xinxiang, these two species occur simultaneously on cotton, their inconsistent densities fluctuate with time and thus compose an unstable mixed population within years, the above results indicated that in resistance monitoring, it is essential to test the two mite species separately, otherwise the results obtained will be indefinite as the test is carried out on a changeable mixed population with different toxic reaction to chemicals. It is also indicated that the omethoate is still a desirable miticide against the two mites, since there is no resistance occurred so far, while the other two miticides are not appropriate for further use in cotton fields.

#26

SYMPTOMS OF INJURIES ON VEGETABLE CROPS CAUSED BY PHYTOPHAGOUS MITES IN EASTERN UTTAR PRADESH (INDIA)

R.N. Singh (Department of Entomology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, INDIA).

Plant abnormalities caused by various agents were well known to many people. It is difficult, however, to recognise the innumerable injuries caused by phytophagous mites because no manual or guide exists for the identification and recognition of plant abnormalities and their mite causal agents. The present attempt was, therefore, intended to fulfil this need by providing essential information on plant abnormalities caused by the phytophagous mites viz., Eutetranychus orientalis, Tetranychus cinnabarinus, Tetranychus ludeni, Tetranychus neocaledonicus, Brevipalpus phoenicis, Aculops lycopersici, Acaphylla sp. and Polyphagotarsonemus latus on vegetable crops in eastern Uttar Pradesh. The key for the identification of causal organisum against its specific symptoms was elucidated in the poster form.

#27

A NEW SPECIES OF GENUS DAIDALOTARSONEMUS FROM FUJIAN, CHINA. (ACARI: TARSONEMIDAE). Jian-zhen Lin, Hao-guan Liu, Wen-fu Peng, Bin Xiao, Yu-mei Chen and Yan-xuan Zhang (Institute of Plant Protection, Fujian Academy of Agricultural Sciences, Fuzhou 350013, China)

This paper described a new species of genus Daidalotarsonemus, D. diovatus sp. nov. Holotype and paratypes were collected from Phyllostachys pubescens Mazel on Oct 24, 1989, and from Tectaria subtriphylla (Hookon et Arn) on Oct 19, 1989 in Lian-chen county. All type specimens are diposited in the Institute of Plant Protection, Fujian Academy of Agricultural Sciences.

#28

ERIOPHYOID MITES INFESTING BAMBOOS IN TAIWAN (ACARINA: ERIOPHYOIDEA). Tsan Huang (Research Institute of Entomology, National Chung-Hsing University, Taichung 40227, Taiwan, China)

Prior to the present study sixteen species of eriophyoid mites in eleven genera were known to infest bamboos in the world, viz., *Abacarus* had 3 spp.; *Acarhynchus, Aceria, Eriophyes* and *Tegolophus* had 2 spp. each; *Dichopelmus, Diptiloplatus, Knorella, Neocatarhinus* and *Neoknorella* had one sp. each.

In the present study, it has been recognized to comprise the fourteen species in nine genera, including twelve new species one of which represents a new genus and the other two species new to Taiwan, viz., *Knorella* has 4 spp.; *Tegolophus* has 3 spp.; *Abacarus, Acamina, Aculops, Apodiptacus, Diptilaseta, Diptiloplatus* and *Schizacea* have 1 sp. each. Thus, in total of twenty-six species in sixteen genera of eriophyoid mites infesting bamboos are known in the world.

#29

Effects of temperature and population life table of Diella litchii Kuang et Feng. Feng Yuanbin Wei Suigai (Guangxi Agricultural College Nanning 530005, China)

Some of the results derived from our laboratory studies on the relationship between temperature and the population dynamics of Diella litchii are presented in the paper. The rates of development of the immature stage of this mite were determined at 5 constant temperatures from 18℃ to 32℃ and fitted to logistic curves. The thermal threshold and thermal sum for the development of a generation were 9.70℃ and 304.99day−degree, respectively. The age schedules of female birth were constructed at 26 ℃, and the parameters were obtained as follows ; innate capacity of population increase (r_m) =0.1236, net reproduction rate (R0) =16.1034, mean length of a generation (T) =22.4770 days and finite rate of increase (λ) =1.1316/day. There are, therefore, 14 generations per year in Nanning locality. The under cooling point is −16.57℃. The relationship between the temperature and the trend indexes of population showed a parabolical trend at 5 constant temperatures. The population of the litchii pest mite from generation to generation tends to grow within the range of 18.37℃−32.45℃ and the highest increasing rate reaches to about 12 times at the most favorable temperature, while it remains almost constant at 18.37℃ or 32.45℃.

#30

SUSCEPTIBILITY OF THE CITRUS RUST MITE, *PHYLLOCOPTRUTA OLEIIVORA* (ASHMEAD), TO DIFFERENT STRAINS OF *HIRSUTELLA THOMPSONII* FIRHER, Chandrapatya, A. (Department of Entomology, Kasetsart University, Bangkok 10900, Thailand), C.W. McCoy (Citrus Research and Education Center, 700 Experiment Station Rd, Lake Alfred, Fl. 33850, U.S.A.).

Seventeen isolated of *Hirsutella thompsonii* representing three distinct varieties, *thompsonii, synnematosa* and *vinacea* were bioassayed against adult citrus rust mite, *Phyllocoptruta oleiivora* (Ashmead). A fungal conidial suspension at a concentration of 10^5/ml was prepared and a 5 ul drop was applied directly onto each mite. After 2 days incubation at 25°C, the number of infected mites were identified microscopically.

Fungal isolates SSi-72, 3W, 13, 5 and 20 were most pathogenic with infection ranging from 49-71%. Isolate SSi-72 is a mutant selected in the laboratory for multiple conidia per conidiophore.

#31

PRELIMINARY STUDIES ON THE BIONOMICS OF THE PEST MITE LUCIAPHORUS AURICULARIAE (ACARI, PYGMEPHORIDAE) INFESTING JEW'S EAR MUSHROOM (AURICULARIA POLYTRICHA) IN CHINA. Ping Zou (Shanghai Academy of Agricultural Sciences, Shanghai 201106, China) Jian-rong Gao (Shanghai Agricultural College, Shanghai 201101)

Luciaphorus auriculariae Gao, Zou et Jiang is a destructive mite to the cultivation of Jew's ear (Auricularia polytricha). It could make yield loss of 10-50% and even a total.

This pest has only egg and adult stages in its life cycle. Eggs developed into adults directly inside their mother's cavity. Mating, lasting 7-12 seconds, could occur both inside and outside the cavity and could carry out about 20 times for a male and once for a female, generally. When the mother's cavity was burst, fertilized females dispered rapidly to search food. On attaining proper places they anchored themselves by gnathosomas to feed and their hysterosomas swelled gradually. At the constant temperatures of 20°C, 25°C, 30°C and 35°C, duration (day) of eggs was 11-20, 6-18, 4-8, 3-5, of adult females 21-33, 10-15, 7-10, 6-9 and the reproductive capacity was 125.35, 128.08, 163.94, 77.25, respectively. This pest could feed mycelia and sporophores of A. polytricha, A. auricula and Flammulina velutipes and could normally develope and reproduce. It could not feed the mycelia of Agaricus bisporus, Pleurotus ostreatus, Tremella fuciformis, Lentinus edodes and sporophore of Lentinus edodes. This pest, When conditions were unfavorable, could thicken its physogastric body wall lined a membrane which wrapped its offsprings for survival.

#32

A REVISION OF SUBFAMILY AND GENUS OF THE FAMILY CUNAXIDAE. (Acari:Acariformes). Gen-sheng Bu, Lung-shu Li (Department of Plant Protection, Southwest Agricultural University, Chongqing 630716, China)

In this paper, the subfamilial and generic classification of the family Cunaxidae is revised. Based on the classification system for Cunaxidae written by J. Den Heyer (1980) and the writers' research, the family is divided into 7 subfamilies, 18 genera. In which 2 subfamilies and 3 genera are newly erected or combined. Descriptions and illustrations are presented for each subfamily and genus.

#33

MULTIPLICATION OF ACARI MITES ON TULIP BULBS UNDER STORAGE CONDITIONS. Czajkowska Barbara /Department of Applied Entomology, Warsaw Agricultural University, 02-766 Warsaw, Nowoursynowska 166, Poland.

Tulip bulbs were stored for 3 months in 25°C and ±70% RH. Part of them had cut tips. Except control they were contaminated with Rhizoglyphus echinopus /F. and R./ and Tyrophagus putrescentiae /Schrank/. Every three weeks samples of the bulbs were taken for checking the rate of increase of the colonies. Initially the mites penetrated external scales but later they reached the flower buds and reproduced mainly there forming frequently multithousand colonies. The bulbs with infested buds showed almost always strong symptoms of bud necrosis, more often connected with R.echinopus than with T.putrescentiae. Bulbs with cut tips had much larger colonies of R.echinopus than of T.putrescientiae. This last species, however, was found more frequently in uncut bulbs.

#34

DIFFERENCE OF BODY SURFACE COMPONENTS BETWEEN PROPAGATIVE FORM OF ASTIGMATID MITES AND THEIR HIPOPUS. Y. Kuwahara, S. Matsuyama, T. Suzuki (Institute of Applied Biochemistry, University of Tsukuba, Tsukuba Ibaraki 305, JAPAN)

Hydrocarbons(HCs) of body surfaces and opisthonotal gland exudates on astigmatid mites consisted of n-alkane, n-alkene and n-alkadiene with carbons ranging from 13 to 19. Their double-bond positions and profiles were determined on 19 species by GLC analysis, using hexane extracts. (Z)-5-tridecene, (Z)-6- and (Z)-7-tetradecene and -pentadecene, (Z)-8-heptadecene, (Z)-9-nonadecene, and (Z,Z)-6,9-pentadecadiene, -heptadecadiene and -nonadecadiene were identified along with corresponding alkane, to give 4 types based on their major component: 1)tridecane type, 2)pentadecane and its unsaturated homologues, 3)heptadecane and its homologues and 4)those of nonadecanes. Three species of hipopus, Rhizoglyphus robine, Schwiebea sp and Histiogaster sp were studied and compared to those of propagative forms of all stages. Their major HCs of propagative forms were tridecane and they belong to type 1. Although major terpenoid components of opisthonotal glands were similarly present in those of hipopus extracts, a significant and also similar changes was noticed in all species of HC profiles. In Schwiebea sp hipopus, HCs were a mixture of heptadecane(1), (Z)-8-heptadecene(43) and (Z,Z)-6,9-heptadecadiene(4.5). HC of Histiogaster sp and R. robine consisted of the mixture of the monoene and diene with reverse ratio (10: 1). Major component of Histiogaster sp was the monoene and that of R. robine was the diene.

Since heptadecadiene seemed to be non-toxic for mites such as type 3 mites ,and heptadecane and its homologues are more durable against evaporation-loss than tridecane, it may be reasonable to conclude that change of body-surface component from tridecane to heptadecane and its homologues enhance durability against desiccation, which is vital for longer survival and phoresy.

#35

SUMMER ALTITUDINAL VARIATION OF SOIL ACARID COMMUNITIES AT CHANGBAI MOUNTAIN, CHINA. Cen-xuan Pan, Kuo-fan Teng (Insitute of Zoology, Academia Sinica, Beijing 100080,China)

In August 1986, fifty samples of soil acarid community structures from eleven habitats located at different altitudes of Changbai Mountain and possessed of different vegetations and their biomass were studied. 13726 specimens belonging to more than 74 species, in which, 37 to oribatids, the dominant ones, 27 to Mesostigmata, 9 to Prostigmata and 1 to Astigmta, were collected. Adult was dominant in this season. The total number, abundance and biomass of species decreased with the ascension of the altitudes. The vertical distribution of species, abundance and biomass were all superficial. The results of Numberical Cladistics, Principal Component Analysis and Similarity Coefficient Analysis showed that the succession of soil acarid communities complied regularly with the change of altitudes and vegetation types.

#36

THE EFFECT OF DELTAMETHRIN APPLICATION ON THE COMMUNITY STRUCTURE OF SOIL ACARIDS IN FARMLAND IN WEST SUBURB OF BEIJING. Xiao-mei Zhang, Hui-fu Wang, Yun-qi Cui,Kuo-fan Teng Institute of Zoology, Academia Sinica, Beijing 100080,China)

9948 soil acarids belonged to 39 genera of 4 suborders were collected in two years from the experimental fields without or with Deltamethrin spraying in west suburb of Beijing. The results of the comparisons of abundance, frequency and diversity, T-test, Principal Component Analysis and Clustering Analysis showed that there was no significant difference between the acarid community structures of the two treatments, indicated that the pollution effect of Deltamethrin on soil acarids is negligible.

#37

COMMUNITY STRUCTURE AND POPULATION VARIATION OF ORIBATIDA IN TIAN-MU MOUNTAIN. Hu Sheng-hao and Wang Xiao-zu, (Shanghai Institute of Entomology, Academia Sinica, Shanghai 200025, China.)

During 1987-1989, an investigation on soil fauna in the Naturat Preserve Area of Tianmu Mountian was conducted. Samptes were collected monthly in five stations with different altitude and vegestation. More than 150 species of oribatid mites betonging to 103 genera of 57 families were found. The community ecology of oribatida was studied in genus level, in which the dominant groups are Oppiidae, Lohmanniidae, Xylobatidae and Mataconothridae. In the natural forest, the lower altitude is, the higher richness index and population density are, the richness index in mixed forest higher than in pure, the Simpson and Shamon Wienner diversity indices show similar tendency. The peak of the oribatid population is often occurred in autumn (Nomverber-December). The similarity index of oribatid community in five stations revealed that the oribatid community doesn't correspond to plant community completely. Anatysis of retative abondance in species number (MGP-anatysis I) and in individal number (MGP-anatysis II) of three major group of oribatida reveal that the oribatid communities in five stations are type O, O, O, MG, O and O, O, MG, MG, O respectivety. The activity of human beings decreases the species and indiviat number of group G (Gymnonota), e.g. in station V.

#38

REVIEW ON THE CHINESE FAUNA OF THE GENUS ARRENURUS WITH DESCRIPTIONS OF TWO NEW SPECIES. Jin Dao-chao (Department of Plant Protection, Guizhou Agricultural College, Guiyang, Guizhou 550025, China)

Arrenurus is a worldwide genus with a plenty of species in water mites, Hydrachnellae. Only 15 Chinese species of the genus were found by Marshall (1928), Uchida and Imamura (1951) and Viets (1938). The author recently described 4 new species (Jin, in press). As the members of Arrenurus have much biological and biogeographical significance, the present paper reviews on the taxonomic studies of the genus in detail so as to research them furtherly.

Two new species described in this paper are: Arrenurus (Arrenurus) binatus sp. nov. (holotype male, allotype female, paratypes 2 males and 5 females); A. (A.) convexus sp. nov. (holotype female, paratypes 2 females). So far 21 species of the genus have been known from China.

The key to the 21 species of the genus is given, besides the distribution and morphology of the species are discussed briefly with 39 taxonomic figures in the present paper.

#39

STUDY ON THE POPULATION DISTRIBUTION AND SAMPLING METHOD OF TETRANYCHUS VIENNENSIS ZACHER. Da-luan Li, Zui-tuan Zhang, Hai-feng Su (Shijiazhuang Pomological Researeh Institute, Agrieulture and Forestry Acadamy of Hebei Provinee, Shijiazhang 050061, China.)

The results of field experiments in many years showed that the spatial pattern of Tetranyehus viennensis Zacher in orehards and erowns belonged to an aggregated distribution pattern. Based upon the study some sampling mathod are mentioned in this paper, and the ehessboard style and paralle-leaping style were the best. It's suggested that 25 leaves per tree, 8 apple tree and 6 pear or peach tree should be investigated to estimate the population densities in orehards.

#40

POTENTIAL USE OF MITES AS BIOLOGICAL CONTROL AGENTS OF GRASSHOPPERS IN TAIWAN. Kang-chen Lo (Applied Zoology Department, Taiwan Agricultural Research Institute, Taichung, Taiwan 41301, China).

Ten parasitic mites were found in Taiwan on grasshoppers. Among them, six species belong to the Podapolipidae, three belong to the Erythraeidae and one belongs to Tydeidae. *Podapolipoides patangae* Lo and *Charletonia southcotti* Kawashima were recorded as more important ones. The grasshopper, *Patanga succincta* L. parasitized by the podapolipid mite did not significantly reduce the longevity, but did significantly reduce the total fecundity and flight ability. Erythraeid mites are an important natural enemy group of grasshoppers in Taiwan. In larval stage, they are paprasitic on grasshoppers, but in nymphal and adult stages, they are predaceous on the eggs or larvae of lepidopterous insects. An average adult female mite in its whole life time consumes about 1000 eggs of rice moth, *Corcyra cephalonica*.

#41

RADIOBIOLOGY OF ACARID MITES /ACARIDA: ACARIDAE/. Stanisław Ignatowicz, Małgorzata Wróblicka-Sysiak /Agricultural University of Warsaw, Department of Applied Entomology, ul. Nowoursynowska 166, 02-766 Warszawa, Poland/

The age of mite eggs at the time of irradiation had a profound effect on their hatchability. The most susceptible stage was the 0-1 day-old egg exhibiting the greatest mortality after the radiation treatment. When older eggs were treated, some larvae emerged. Radiosensitivity of acarid mites decreased during their development. The adult stage was the most resistant to gamma radiation. Sterility in mites was achieved following treatment of adults at much lower doses than needed to kill these pests. When both sexes of the acarid mites were irradiated with doses higher than 250 Gy, the mites produced several eggs all of which were sterile. Females of acarid mites were clearly more radiosensitive than males, as shown by the differences in reproductive abilities of irradiated adults mated with untreated opposities. Normal mites produced eggs during almost the whole period of their life. Irradiated mites produced eggs during the first weeks, being infecund thereafter.

#42

VARIATION IN INSECTICIDE RESISTANCE AND INDUCTION OF DIAPAUSE IN THE PREDATORY MITE AMBLYSEIUS LONGISPINOSUS (EVANS) (ACARINA:PHYTOSEIIDAE). Masatoshi Mochizuki Department of Tea Agronomy, Natl. Res. Inst. of Vegetables, Ornamental Plants and Tea, Kanaya, Shizuoka, 428, Japan.

Multiple(OP-Carbamate-SP) resistant population and non-diapausing population were found in the A. longispinosus populations.

Eleven populations were collected from commercial tea fields in Shizuoka prefecture.(Central part of Japan) and insecticide resistance was assessed by the leaf disk spray method in the laboratory. One population could survive the field rate of methidathion, methomyl and permethrin.

Induction of diapause was also investigated for two populations (Shizuoka and Okinawa) under 9L(20° C):15D(10° C) condition. After each population was mass-reared and mated, oviposition of every individuals was checked daily. Although oviposition of the Shizuoka population was strongly suppressed for about 3 weeks, more than 80% tested females of the Okinawa population continued oviposition.

I concluded that multiple resistant non-diapausing strain would be established by combining and selecting these two populations in the laboratory.

#43

LOCAL VARIATION IN DIAPAUSE CHARACTERISTICS OF *TETRANYCHUS URTICAE* KOCH (ACARINA: TETRANYCHIDAE).

Ping-Man So, Akio Takafuji (Entomological Laboratory, College of Agriculture, Kyoto University, Kyoto 606, Japan)

Diapause characteristics of nine local populations of *Tetranychus urticae* Koch (Acarina: Tetranychidae) occurring on roses in central Japan were investigated. The percentage of females that entered diapause at 18°C and 9L-15D photoperiod ranged between 0 and 77%. In addition, both photoperiodic and temperature responses varied widely among these populations. We suggest that temperature response might be a better trait than photoperiodic response for selection among local populations. Females in diapause survived -24°C better than those which were not. However, no difference in cold-hardiness among these populations was found. The mite responded rapidly to artificial selection for low and high diapause percentage. The response was asymmetrical, being easier in the direction for low diapause percentage. Reciprocal and backcrosses using selected low and high diapause percentage cultures showed that the genetic control of diapause was complicated. Neither the 'low-diapause' nor the 'high-diapause' trait dominated over the other. However, the 'low-diapause' trait seemed to be stronger. The results of this study suggest that variation in diapause response is maintained by (1) adaptation to local environments and (2) the complexity of the genetics of diapause. Such variation may provide the genetic 'raw-material' for natural selection and is a prerequisite for the extension of ecological range.

#44

SURVEY OF STUDY AND UTILIZATION OF PREDACEOUS MITES IN CHINA.

Zhu Zhi-min, Lai Yong-fang (Department of Biology, Jiangxi University, Nanchang 330047, China) .

This paper gives a summary of the results obtained in the researches on the utilization of predaceous mites that have been made in China since 1975. There are six species of the phytoseiid mites that bave been applied to controlling the pest mites in fields, but only four of them, Amblyseus nicholsi Ehara et Lee, A. orientalis Ehara, A. deleoni Muma et Denmark and A. pseudolongispinosus Xin, Liang et Ke, have been more often used in practice. The phytoseiid mites introduced from abroad add up to three species, they are A. fallacis Garman, Phytoseius persimilis Athias-Henriot and Typhlodromus occidentalis Nesbitt. Besides those mentioned above, other ten species of the six families of predaceous mites, the utilization of which has been preliminary studied, and some biological characteristics related to the utilization of predaceous mites, are introduced in this paper.

STUDIES ON PILMONARY ACARIASIS IN CHINA. Xing-bao Chen (Department of Parasitology, Bengbu Medical College, Benbu, Anhui 233003, China)

658 persons were examined who engaged with grain, tridítional medicinal herbs, tobacco and textile. The sputum mites of 153 persons showed positive, of whom 101 cases of pulmonary acariasis were dianosed based on sputum and other laboratory examination and clinical manifestation and the incience was 15.35%. 16 species of the sputum mites were identified which mainly belong to Tarsonemidae and Acaridae. Pured living mites were injected into the trechea of guinea-pigs to form animal model of pulmonary acariasis, meanwhile the pathological changes of the lung tissue were observed, and the pathogeny of 5 common mites were compared after injected into 5 groups of guinea-pigs respectively. The pathogenic factors mainly included 2 aspects:mechanic injuries caused by infesting mites and allergic reaction caused by soluble antigen of parasitic mites. All the patients, divided into 3 groups were treated with Metronidazole by different dosages and therapies, and were cured.

A TAXONOMIC STUDY ON PYEMOTOIDEA AND PYGMEPHOROIDEA (ACARI) FROM CHINA. Jian-rong Gao* Ping Zou** En-pei Ma* (Shanghai Agricultural College, Shanghai 201101, China. **Shanghai Academy of Agricultural Sciences, Shanghai 201106, China)

Acout the mites of Pyemotoidea and Pygmephoroidea, only a little knowledge was known in China before 1980's. Since then we paid great attention to them because of their economic importance and began to take the taxonomic study on this group. Up to now, 50 species belonging to 15 genera of 5 families were known from China. Of these, 18 species were new to science. They are listed here: Dolichocybe perniciosa, D. shenagarici, Allopygmephorus baoshanensis, A. nanhuiensis, Brasilopsis shanlentini, Luciaphorus auriculariae, Pediculaster huochenger, Pe.minagarici, Pe. shiheziensis, Pe. subarcanus, Pseudopygmephorus agarici, Ps. chinensis, Ps. lichenis, Ps. shanghaiensis, Ps. shanxiensis, Ps. tianshanus, Sicilipes fengxiannus, Siteroptes xizangensis. With lab. and field studies, it was proved that Brennandania lambi (Krczal, 1964) was a destructive pest to the cultivation of mushroom (Agaricus bisporus), that Luciaphorus auriculariae Gao, Zou et Jiang, 1990 was a very important pest to the cultivation of Jew's Ear, that Dolichocybe perniciosa Gao et Zou (in press) was a major pest to the production of edible fungi, and it not only fed edible fungi such as Lentinus edodes, Auricularia auricula, A. polytricha, Tremella fuciformis and Ganoderma lucidum but also fed weed molds and transmitted them to mushrooms, and that Siteroptes spp. were principal vectors of some pathogens which reduce the yield of cereal crops greatly.

STUDIES ON THE TAXONOMY OF TETRANYCHOIDEA (acari) FROM CHINA. En-pei Ma, Jian-rong Gao (Dept. of Landscape and Env. Sci., Shanghai Agricultural College, Shanghai 201101, China)

The systematic studies on the taxonomy of Tetranychoidea in China began in mid 1960's, although seven species had been recorded before, but it was in 1970's that considerable progress was made. For more than 30 years countrywide investigations have been carried out by En-pei Ma, Yi-lan Yuan, Hui-fu Wang,Yi-hsiung Tseng and Kang-chen Lo, etc.. Up to now, 204 species belonging to 33 genera of 3 families have been recorded in China. Of these a tribe and 6 genera were erected by above researchers as new to science. The new tribe and genera were listed as follows.

Sinobryobiini Ma, Gao et Chen, 1990
Sinotetranychus Ma et Yuan, 1980
Chinotetranychus Ma et Yuan, 1982
Acanthonychus Wang, 1982
Yunonychus Ma et Gao, 1985
Sinobryobia Ma, Gao et Chen, 1990
Xinella Ma et Wang, 1991

Besides, Yi-hsiung Tseng proposed a new genus Bakerileptus in 1975 on the basis of an American species Pseudoleptus zalihae Pritchard et Baker as type.

STUDY ON THE METHODS OF CONTROLLING MUSHROOM MITES. Ju-fang Wu, En-pei Ma (Shanghai Agricultural College,Shanghai 201101, China)

After investigation Brennendania lambi (Krczal) is considered to be the most important mite in Shanghai, although other species are pest when they build up largely. When sanitary condition of environment is not good, mite damage is specially serious.

For completing its life cycle, B. lambi not only can live on Agaricus bisporus but also can live on Tremella fuciformis, Hercium erinaceus, Auricularia polytricha, A. auricula. The adult bred by Pleurotus ostreatus, P. sajor-caju, Lentinus edodes, Flammulina velutipes can live about 12-32 days, but can't breed its coming generation. Some species of Acaridae, Pygmephoridae and Histiostomidae may take several fungi, it is no doubt that they invade mushroom by several ways. Up to now the major source of damage caused by B. Lambi is the spawn which the mite comtaminates.

In order to control these mites, following methods can be adoped:

1) Peak heating mushroom compost to kill mites.

2) Pay attention to environmental sanitation to protect mushroom from mite damage.

3) Clean the room having been planted other edible fungi or stacked some materials, after that, keep all doors and windows open for 2 to 3 weeks before planting mushroom.

4) Freeze spawn to eliminate B. lambi.

THE COLONISATION OF NEW HOUSES BY HOUSE DUST MITES. Wietske.A.D. van der Hoeven, Rob de Boer (University of Amsterdam, Section Population Biology, Kruislaan 302, 1098 SM Amsterdam, The Netherlands)

Dermatophagoides species (Acari: Pyroglyphidae) produce allergens known for the provocation of asthma and other allergic reactions. To determine the time needed for complete colonisation of a new house by house dust mites, dust samples were collected from carpets of houses varying from two weeks to two years in age. In contrast to the expectation, no relation was found between age of the houses on the one hand and average levels of mite-allergens *Der p*I and *Der p*II and mite numbers on the other. Neither was the age of the mattress related to allergen levels of bedroom floors. Major factors correlated to allergen levels appeared to be the presence of dogs and the locations of carpets in the house; carpets in bedrooms contained more allergens than carpets in livingrooms.

PARASITISM: ECOLOGICAL INTERACTIONS AND THE EVOLUTIONARY CONSEQUENCES IN TWO INSECT-MITE INTERACTIONS. Marilyn A. Houck (Department of Biological Sciences, Texas Tech University, Lubbock, Texas, 79409-3131, USA).

Two insect-mite interactions will be detailed. A mite of the genus Hemisarcoptes, a generalist predator of Diaspidid scale insects, will be discussed in terms of the potential role of phoresy in the evolution of parasitism in the Astigmata. A second genus, Proctolaelaps will be discussed in terms of the potential effect of parasitism on horizontal gene transfer among Drosophila species. There is corroborating evidence, from several independent research areas, that horizontal gene transfer of the P transposable element has recently occurred between Drosophila melanogaster and a species of Drosophila from the willistoni group. Using Southern blot hybridization, PCR amplification and DNA sequencing, it was determined that samples of P. regalis associated with a P strain of D. melanogaster carried P element sequences. Similarly, Drosophila rDNA sequences were identified in P. regalis samples that had been associated with Drosophila cultures. Most consequentially, this mite has the morphology and behavior consistent with mechanical vectoring. It is also ecologically syntopic with D. melanogaster, both being native to southern North American. These results will be discussed in terms of the general attributes of P. regalis which led to its choice as a study organism, and the potential for such horizontal transfer in other insect-acarine interactions. Speculation concerning the relevance of horizontal transfer to host-parasite interactions will be offered.

THE PLANTSCAPE TO THE LANDSCAPE IN INSECT CONSERVATION
Samways, Michael J. (Department of Zoology & Entomology, University of Natal, Pietermaritzburg 3200, South Africa).
The mobility of insects is intimately associated with their selection of micro-habitat and habitat at different stages in their life-histories and at different times throughout the day. Habitat fragmentation and loss worldwide is the major threat to the future of insect fauna. This is compounded by global atmospheric impacts. The concepts of geographical scale and ecological interactions is vital in conservation biology. Insects, their habitats, ecosystems and landscapes are intimately related to the global situation. Fragmentation of landscapes is leaving behind small patches where insect populations are prone to extinction. A landscape with high connectivity between patches, and variable topography offers the greatest opportunity for conservation of insect species and their interactions with other organisms.

INSECT CONSERVATION AND BIOLOGICAL CONTROL: ARE THEY COMPATIBLE? Donald Nafus (AES, CALS, Univ. of Guam, Mangilao, Guam, U.S.A. 96923)

For many years biocontrol was considered to be environmentally safe, but recently biocontrol agents have been critized as seriously damaging, or perhaps even causing the extinction of populations of native species. The demonstration of negative environmental impacts on native species raises the question of whether biological control is compatible with the conservation of native insects.

Biocontrol importations are generally targeted at accidentally introduced alien species. These aliens enter without natural checks, and can reach high abundances, adversely affecting a wide variety of native and introduced plants or ecosystems. Introduction rates of pests and beneficial species and their ecological and environmental effects are discussed using Guam as a focal point. Specific examples include the Hypolimnas, shifts in the abundance of nontarget species of Lepidoptera on mango in relation to the introduction of biocontrol agents, and changes of abundances of exotic and native predators attacking the leucaena psyllid and their potential environmental effects. Benefits and problems with deliberately introduced biocontrol agents are presented and contrasted with other problems such as accidentally introduced predators and parasitoids and habitat destruction. The future of biocontrol on islands is discussed.

INSECT CONSERVATION IN THE NEOTROPICS IN RELATION TO LAND USE MODELS. Keith S. Brown Jr. (Deptº Zoologia, Inst. de Biologia, UNICAMP, C.P. 6109, Campinas, Sao Paulo 13.081 Brazil).

Neotropical forests include the greatest known biodiversity in almost all plant and animal groups, and are especially rich in insects. The extensive niche specialization which is both a result and a cause of this diversity, implies a special sensitivity to habitat alteration, which even by the very local elimination or modification of adaptive genes, could lead to a reduction in biodiversity. Coexistence of human populations with these forests, utilization of their resources, conversion of their habitats, and struggle against insects which become disease vectors, pests, or nuisance factors to humans, have led to several models of land use whose degree of conservation of insect biodiversity varies widely. Studies in the Brazilian Amazon forests (still 90% intact, including various types of human occupation, destruction, and regeneration) and Atlantic forests (about 12% remaining, subjected to extensive removal by industrial sociaety) have shown that traditional extractive uses by indigenous or isolated, low-density human populations, or miniagricultural mosaics with forest, tend to integrally conserve, maintain, and even enhance the biodiversity of insects and their host plants, with minimal disruption of systems and processes; while larger-scale economic occupation or conversion of the forests results in great reduction of biodiversity. Since biodiversity is not evenly distributed in the forests, insects have served as important indicators for the zoning of land use in both forest regions, permitting rational plans for the conservation of a maximum of biodiversity in systems protected or maintained in harmonious relationship with their human occupants.

EFFECTS OF EXOTIC SPECIES ON AUSTRALIAN NATIVE INSECTS
T.R. New (Department of Zoology, La Trobe University, Bundoora, Victoria 3083, Australia)

Numerous exotic animal and plant species have invaded, or been introduced into, Australia during the approximately 200 years of European settlement. They are now significant biotic elements. Their effects on native biota have been substantial and largely detrimental, and range from major habitat and resource changes to subtle interactions with native species. Native insects and other invertebrates are vulnerable to such invasions in many ways, but there are few well-documented cases of extinction, and much of the 'evidence' for their decline caused by exotic species is extraordinarily difficult to evaluate. Evidence and speculation on the effects of exotic species on the wellbeing of ecologically sensitive native insects is summarised, and their roles evaluated.

INSECT CONSERVATION AND EXTENSIVE AGRICULTURE: THE SAVANNA OF SOUTHERN AFRICA. C.H. Scholtz , S.L. Chown (Department of Entomology, University of Pretoria, Pretoria 0002, South Africa).

The savanna biome, which comprises 46% of southern Africa, consists of a mosaic of remarkably different habitats, ranging from valley bushveld to *Brachystegia* miombo. Geographically, it also includes a number of disparate vegetation types such as localized gradients of dry and wet savanna, Afromontane forest and high-altitude fynbos. Despite fairly intensive research into the functioning of this biome, the role of insects is currently underrated. Conservation efforts have mainly been directed at the spectacular and endangered large mammals. Given the success of the latter, many unique habitats and species, threatened by agricultural development, short-sighted management and rural population growth, are yet to be fully appreciated and consequently have uncertain futures. Here, we review the conservation status of representative and unique insect habitats and species in the context of agricultural and population development, current conservation practises and legislation.

ARID LANDS AND GRASSLANDS: TWO NEGLECTED AREAS FOR INSECT CONSERVATION IN AUSTRALIA. Penelope Greenslade, (CSIRO Division of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia)

Forests have traditionally received most conservation attention in Australia because they are conspicuous, are currently being spectacularly exploited and are widely appreciated aesthetically by the non biologist. However they cover only 5% of the continent, a reduction from the estimated 9% at settlement. By contrast nearly eighty percent of Australia is classified as arid or semi-arid and is exploited for grazing by introduced stock and colonised by feral herbivores such as rabbits. In combination with drought degradation of the landscape has resulted. Native grasslands have also only recently come to the attention of the conservation movement when it was pointed out that in some regions only 1% of native grassland remains having been gradually replaced by exotic grasses. The extent to which degraded arid lands and exotic grass species can provide habitat for native invertebrates will be illustrated by examples from different regions of Australia. .Some remedies to the loss of these habitats will be discussed.

ORTHOPTERA AS INDICATORS OF THREATENED HABITATS IN AUSTRALIA. D.C.F. Rentz (Division of Entomology, GPO Box 1700, Canberra, ACT 2601, Australia)

In an arid land like Australia orthopteroid insects are a predominant part of the landscape. The present state of the taxonomy of these insects is such that less than half the species have been described and are therefore largely unknown in the literature. Scientists have dealt with this Taxonomic Impediment by ascribing numbers to undescribed genera and species. But this large literature deficit has resulted in a similar lack of published ecological and other bionomic information on these insects.

My studies in the Ensifera (tettigoniids, stenopelmatids, gryllacridids, rhaphidophorids, cooloolids and grllids) suggests that these insects (and probably other Orthoptera) can be useful indicator-species in helping to arrive at decisions concerning remnant habitats.

Tettigoniids and cooloolids will provide the bulk of the examples which will be centred around primarily agricultural areas, especially in the wheat belt of the southern portion of Teh continent. The proposed use of grasshoppers as indicator species in prescribed burn areas will also be mentioned.

THE ROLE OF MUSEUMS AND ZOOS IN INFLUENCING PUBLIC ATTITUDES TOWARDS INVERTEBRATE CONSERVATION. Alan L. Yen (Invertebrate Survey Department, Museum of Victoria, 71 Victoria Crescent, Abbotsford, Victoria 3067, Australia)

One of the major barriers to the conservation of invertebrates is the concept that invertebrates are pests which should be eliminated rather than conserved. A change in public, political, and even scientific attitudes is required before invertebrate conservation is generally accepted with the same level of support that vertebrate conservation currently attracts. This change can be stimulated by collaborative research and educational programmes involving museums and zoos. These programmes include live and static invertebrate displays, captive breeding of threatened species, and in-situ invertebrate conservation projects.

CHINESE VIEWPOINTS ON THE VALUES, UTILIZATION AND CONSERVATION OF INSECT RESOURCES. Pingshih Yang (Dept. of Plant Pathology and Entomology National Taiwan Univ, Taipei, Taiwan, China)

Insects are the most abundant animal in the world, in Taiwan the known species of insects at least 17,609 now, and in Mainland China at least 55000. Although some of them are pests, most of insects still play an important role in ecosystem, economic utilization, research, education, even though in Chinese medicine, literature, art, recreation, and religion.

Taiwan had been widely known for butterfly industry, but this industry has declined recently. Whatever in Mainland China it is a potential enterprise in the future. In this paper, some problems associated with insect utilization and conservation will be mentioned and discussed. , 1) values of insect resources for Chinese., 2) the causes of insect decline such as habitat destruction and overcollecting., 3) the history and situation on the utilization and conservation of insect resource. , and 4) the rearearch, legistrative limitation, and some efforts of the insect conservation from the government and societies.

INSECT SYSTEMATICS AND THE CONSERVATION OF BIODIVERSITY: GLOBAL,NATIONAL AND LOCAL PERSPECTIVES. R.I.Vane-Wright (Biodiversity Division, Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK)

Conservation effort is focussed at three political levels: global, national and local. To be fully effective, insect systematists will need to respond to the differing requirements of all these levels. At the local level, primary concerns will include the provision of practical identification keys, monitoring work, and an active role in natural history education. At the national level, major roles will include the preparation of inventories (check-lists, distribution maps), and collaboration with ecologists, conservation evaluation specialists and resource planners to produce efficient national plans for biodiversity conservation. At the global level we will need to develop a world overview and analysis of insect diversity, in relation to the diversity of other organisms. This will enable recognition of regional and international priorities for funding, technological and other assistance to nations willing but financially unable to support necessary conservation action. For all of this work, the critical importance of systematic revisions and distribution data will be stressed, and an evaluation programme for assessing global priorities will be described.

ALL ELSE IS NOT EQUAL: TEMPORAL POPULATION VARIABILITY AND INSECT CONSERVATION Kevin J. Gaston (Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.) and Brian H. McArdle (School of Biological Sciences, University of Auckland, Private Bag, Auckland, New Zealand).

All else being equal, populations which fluctuate to a large extent through time will have a greater probability of extinction than those which do not. Temporal variability is thus potentially a useful measure, as it suggests the possibility that species could be ranked according to their rough risk of extinction. It is readily apparent, however, that all else is not equal. Populations differ in many ways, such as their size, structure, and connectedness. Such factors may variously affect levels of population variability in predictable or unpredictable ways, often with important implications for insect conservation. An improved understanding of the determinants of temporal population variability should therefore lead to better management of populations, particularly of rare species. Moreover, a sound knowledge of the usual patterns of variability and their determinants may enable detection of the unusual.

BIOLOGICAL DIVERSITY BETWEEN *BEMISIA TABACI* FROM DIFFERENT CONTINENTS. Peter G Markham, Ian D Bedford, Robert W Briddon (Department Virus Research, John Innes Institute, Colney Lane, Norwich, Norfolk, NR47UH, U.K.) Judith K Brown and Heather S Costa (Department of Plant Pathology, Forbes Building, University of Arizona, Tuscon, AZ 85721, U.S.A.)

Bemisia tabaci have increased in importance in recent years as both pests and virus vectors. New records indicate a spread into new regions. Reports indicate that some new populations have extended host ranges. We have collected more than 20 populations of *B.tabaci* from North and Central America, the Caribbean, West Africa, North Africa, the Middle East, and Asia. Colonies have been compared for morphological differences by light and by scanning electron microscopy. Large variation in size was apparent but taxonomic characteristics conformed to the species. The presence and position of pupal setae varied for a colony depending on the surface structures of the leaf, both between hosts or upper and lower surface. Host range of colonies varied from a few to most of the hosts tested. The ability to cause toxin-induced feeding damage, such as silverleaf, was found in colonies from Florida, California, Arizona and the Yemen. These colonies also gave the same esterase patterns; while other colonies gave differing patterns. Colonies were also successfully finger-printed using PCR-amplified DNA. The RAPDs (Random Amplified Polymorphic DNAs) using long sequencing primers gave the best results. Colonies were tested for their ability to acquire and transmit 10 geminiviruses. The Florida colony transmitted all viruses to the largest number of alternate hosts. One colony from Benin would only transmit one virus. Host range was more important in transmission than acquisition. Abutilon mosaic and honeysuckle yellow vein viruses were not transmissible; nor were three other infectious, cloned viruses.

THE SOIL ENTOMOFAUNA OF MOUNTAIN FORESTS IN THE NORTHERN TIEN SHAN AND PROBLEMS OF THEIR CONSERVATION. B.Striganova (Institute of Animal Evolutionary Morphology and Ecology, Russ. Acad. Sci., Moscow 117071, Russia)

The taxonomical and structural diversity of a soil invertebrate population in forest ecosystems was studied at different altitudes of the mountain macroprofile of the Terskey Ala Too Ridge (Northern Tien Shan). Forest stands are formed there by Picea schrenkiana. Structure peculiarities of soil insect communities were found to depend on both height and local hydrothermal conditions. Few types of animal communities characteristic of separate forest parcels distributed along the whole forest profile. Their spatial localization was found to correlate with a ground plant cover. Adaptive strategies of soil insects in high-mountain ecosystems near the upper timberline were studied. Problems of soil animal communities in the presence of intensive anthropogenic press are discussed.

A COMPARISON OF THE SOIL MACROCOLEOPTERAN COMMUNITY IN SHADED AND UNSHADED COFFEE SYSTEMS IN MEXICO. David Nestel (Institute of Plant Protection, Volcani Center, P.O.B. 6, Beit-Dagan 50250, Israel).

Soil coleopterans were sampled with pitfall traps during the rainy and dry season (1989-89) in two types of coffee agroecosystems: unshaded and shaded coffee. A total of 32 species, representing 9 families of terrestrial coleopterans, was sampled during the two seasons and in the two types of coffee. The rainy season was more productive in insect species and individuals than the dry season. In addition, insect diversity and eveness (calculated with the Hill's series of diversity numbers) was greater in the shaded than in the unshaded coffee. It is suggested that the maintenance of shade trees in coffee systems improves diversity and sustainability of coffee systems.

ADVANCE OF RESEARCH ON HOST SWIFT MOTH OF INSECT-HERB. Zuxun Gao, Hong Yu, Jian Chen (Zhejiang Agricultural University, Hangzhou 310029, China), Zhihong Zhao, Huiming Song (Zhejiang Academy of Agricultural Science, Hangzhou 310021, China)

It is proved that the main swift moth of insect-herb (Cordyceps sinensis) in Kangding County of Sichuan Province is the Hepialus oblifurcus Chu et Wang. The research on the life cycle of this swift moth has been completed. Four key problems in mass rearing of this swift moth in low altitude area have been resolved including diet, rearing condition, technique and disease prevention.

THE CHANGING LANDSCAPE OF BOREAL FOREST: EFFECTS OF LOGGING ON CARABID ASSEMBLAGES IN WESTERN CANADA. Jari Niemelä (Dept. of Entomology, Univ. of Alberta, Edmonton, Alberta, Canada T6G 2E3) David Langor (Forestry Canada-Northwest Region, 5320-122 St., Edmonton, Ab, Canada T6H 3S5), John R. Spence (Dept. Entomology, Univ. Alberta, Edmonton, Ab, Canada T6G 2E3).

We studied the effects of logging on carabid assemblages in lodgepole pine forest by comparing pitfall catches from regenerating sites cut 0, 2, 9, 14-19 and 27 years ago with catches from mature forest. Beetles were most abundant in the young regenerating sites and in mature stands on moist soil. Species richness was highest in the regenerating sites where several species favouring dry and grassy habitat were collected. The carabid fauna of the sites grouped in a cluster analysis according to the forest age. Differences in carabid assemblages among the stands could reflect variation in habitat parameters, landscape effects of logging, or both. Four types of species responses to forest cutting were distinguished: (1) species of open habitat increased in number and abundance, e.g. genera Amara and Harpalus, (2) forest generalists were not noticeably affected by logging, (3) mature forest generalists decreased but recovered strongly, and (4) rare mature forest specialists may be lost due to continued habitat change and increasing fragmentation of old growth.

THE PROBLEM OF INSECT PROTECTION IN THE USSR. Kochetova N. I. (All-Union Institute of Nature Conservation, Znamenskoye-Sadki, Moscow, Rassia 113628).

At present in the Red Data Book of the USSR there are 202 species of insects. Now in our laboratory we have the new list for the next edition of the Red Data Book of the USSR. The new list contains not only species, but the taxa more high rank (families, gerera and so on). For example, we are going to include all ordo Grylloblattida, all family Papilionidae. The number of categories will be enlarged as well. We are going to include the communities of invertebrates, as it was done in IUCN Invertebrates Red Date Book: the communities of European stepps, oak-groves, caves (Caucasus, Middle Asia, Far East). We use the same categories both for taxa and communities: probably extinct, endangered, vulnerable, rare, indeterminate, insufficiently known. We are going to use such categories as "threatened fenomenon" and "commercially threatened taxa".

CULTIVATION OF COMMERCIAL INSECT SPECIES IN USSR.
Gorbatovsky V.V. (All-Union Institute of Nature Conservation, Znamenskoye-Sadki, Moscow, USSR, 113628

The breeding of commercial species of insects, including the ones from the USSR Red Data Book is not made at present. At the same time it is necessary such cultivation. That will allow to.secure constant reserve for addition and restoration natural populations and decrease the catching them in natural habitats because of market fulling. by artificial getting specimens. These specimens are better look due to good preservation (keeping). The programm of cultivation commercial insects must be complex and include next aspects: 1.The creation and development set of zonal centres of breeding; 2. The study of biology of breeding species and working out the laboratory cultivation and technological regulations of large-scale production; 3. The creation and supporting of mother's cultures; 4. The large-scale cultivation of insects with necessary compensatorial return to the natural habitats of mother's material; 5. The working out of rules of trade and export (for protected species); 6. The realisation of constant control for taking from habitats, cultivation and compensatorial return, trade and export.

BIOSYSTEMATICS AND PROBLEMS OF THE CONSERVATION OF BIODIVERSITY. V.E. Zaitzev. Zoological Institute, Russian Academy of Sciences, St. Petersburg.

The huge insect world is a layer situated at the base of the pyramid of life. The first serious difficulty faced by the scientists developing the principles of the conservation of biodiversity is the insufficiently studied systematics of many groups of insects and mosaic knowledge about terrestrial insects. One other important feature of insects which should be taken into account in the study of biodiversity is separation of habitats in larvae and adults in the largest orders of insects. Every hour and evry day a great many of animal and primarily insect species disappear. One can check disappearance of mammals, birds, reptiles, and fishes by means of protecting some particular species, creation of data banks, whereas in insects and most invertebrates an optimum level of biodiversity can be only maintained by preservation of coenoses as a whole.

An imporotant aspect of the study into biodiversity is preservation of the information about the animal world accumulated in collections of museums and research institutions.

#1
STUDIES ON HYMENOPTERAN BIODIVERSITY: COMPARISON BETWEEN TWO NATURAL AREAS IN THE PROVINCE OF MADRID (SPAIN). J.L. Nieves Aldrey and C. Rey del Castillo. Museo Nacional de Ciencias Naturales (Biodiversidad), José Gutiérrez Abascal, 2, 28006 MADRID (SPAIN).

This study is a part of a Research Proyect on Insect Biodiversity carried out since 1988 to 1991 in two natural areas in the Madrid province (Central Spain). The first sampling site, "El Ventorrillo", is a mountainous, humid area in the Sierra de Guadarrama; the second, "El Pardo", is a well preserved Mediterranean evergreen oak forest, near the city of Madrid. Preliminary results showed that abundances of Hymenoptera were very high at the first area of study while they were almost twice lower at "El Pardo". In the two areas Parasitica amounted more than 80% of total captures but samples from the second showed significatively higher rates of Aculeata as well as lower of Symphyta. For some families, data are given on richness and diversity and results from the two sampling areas are compared and discussed. Finally a comparison is made on the relative efficiencies of the two employed sampling methods. Malaise trap was found to be a very effective method of sampling and just a single trap at "El Ventorrillo" working along one complete annual cycle trapped ca. 61200 individuals of Hymenoptera.

#2
INVESTIGATION ON THE NATURAL RESOURCES AND UTILIZATION OF THE CHINESE MEDICINAL BEETLE-MELOIDAE. Juan-jie Tan, You-wei Zhang, Wen-zhen Ma(Institute of Zoology, Academia Sinica,Beijing 100080) Zheng-ji Deng,Chuan-xian Zhu(Sichuan Institute of Chinese Materia Medica, Chongqing 630065, China)

The Cantharidin of Meloidae has long been used medicinally both in China and western countries. In China its medicinal usage may trace as far back as 1-2 B.C., In "Shen Nong Materia Medica." In recent years in the "Pharmacopoeia of the People's Republic of China"(1985), there are listed 10 different kinds of medicinal insects and their products, of which 2 species of Meloidae are included. In order to protect and also for the better usage of the natural resources of Meloidae, the authors have carried out an extensive survey of Meloidae from year 1989-1991 in 6 provinces. In three years time we ascertain that among the 35 common species collected, there are 3 genera and 19 predominate species. The degree of cantharidin c ontained in the adults of the above species were determined by gas Chromatography and thin layer chromatography methods. The results show that about 70% of the species containing cantharidin exceed 0.35%. So the present investigation greatly increased the number of Meloid species to be used as medicine. The results also show that the degree of richness of cantharidin varies among individuals of the same species collected from different localities, to this problem further investigation is needed.

#3
DECLINE AND CONSERVATION OF BUTTERFLIES IN FUKUOKA CITY: TRIAL OF MONITORING. Yata, O. (Biological Laboratory, College of General Education, Kyushu University, Ropponmatsu, Fukuoka, 810 Japan)

In Fukuoka, the largest city in Kyushu, Japan, the decline of butterflies and other insects becomes noticeable with the increased threatening by human activities such as urbanization. To obtain the evidence, a comparison of the butterfly faunas between 1953 and 1991–92 was made by conducting the route census method (transect recording) at 2 sites ("Hirao" and "A campus of Kyushu University"). The results show that the number of both individuals and species (the relative abundance) has drastically decreased and the species composition has markedly changed.

In addition, in order to know the degree of conservation of natural environment in the city, the number of individuals and species, species composition, species diversity, ranking of species in order of abundance, etc. were investigated in 3 natural parks by the same method. Further, the results obtained were compared with those at "Yamada Ryokuchi" (a nature reservation in Kitakyushu) and 3 other human residential areas in Fukuoka-city.

Considering the recent rapid decline of butterfly fauna in Fukuoka, the natural parks such as Minamikoen, Konosuyama and Aburayama are essential areas not only for conserving the green zones, but also for monitoring the change of biotopes.

#4
STUDIES ON ULTRASTRUCTURE, BIOLOGICAL CHARACTERISTIC AND MERIDIC DIET OF LUEHDORFIA CHINENSIS, A RARE AND ENDANGERED BUTTERFLY. Jian Hong, Cui Hu, Gong-yin Ye and Xiao-jin Wu (Department of Plant Protection, Zhejiang Agricultural University, Hangzhou 310029, China)

Luehdorfia chinensis Leech was declared by Chinese government as one of the national protective animals(second-class) in 1989. It occurs one generation every year, oversummers and overwinters as pupae in Hangzhou, China. The ultrastructures of egg, larval head, adult antenna and genitalia etc. were observed with electron microscope. The span of egg, larva, pupa or adult, egg's development zero and effective temperature summation, larval food consumption, larval feeding characteristics, and fecundity were investigated. Through two orthogonal experiments, five better formulae were selected among seventeen ones containing the leaf flour of Asarums forbesii as leaf factor. Reared with the best one, mean total larval stadium, pupation rate, mean pupal weight and emergence rate of the butterfly were 11.83 days, 50.00%, 310.38mg and 40.00%, respectively. These indexes of the check reared with fresh leaves were 36.80 days, 69.43%, 352.68mg and 60.98%, respectively.

#5
DECLINE AND CONSERVATION OF THE Luehdorfia puziloi IN THE CASE OF MT.AKAGI IN GUNMA PREFECTURE IN JAPAN. Takayoshi Matsumura (827-5 Fujioka Fujioka-shi Gunma 375 Japan)

There are only four species of Luehdorfia known in the world and they all are distributed in East Asia. In Japan, L.puziloi and L.japonica are distributed, and segregated by their habitat, and by the Luehdorfia-line.

In Japan, the L.puziloi, has two subspecies, the inexpecta and the yessoensis. The phyletical relationship between ssp.coreana in South Korea, ssp.puziloi in Ussuri, and other species of the Luehdorfia is a very interesting subject.

Mt.Akagi is one of the isolated habitats of the L.puziloi. The population of this area is a very important key to understanding the differentiation of these subspecies.

In Japan, some local populations of butterflies have been exterminated within the past 30 years. Most of them were living in the forest near settlements. The industrialization of Japan has forced them to go deeper into the mountains, and to lead them closer to extinction. The L.puziloi is one of these victims.

I am working to conserve the remaining population in the small area of Mt.Akagi. In this area I have observed less than 50 individuals. Now I am watching out for the condition of the habitat, food plant and the forest, and trying to prevent the young larva from predation by natural enemies.

At this congress, I hope to meet someone who can help me in the phyletical study on the Luehdorfia, and I wish to exchange opinions on the situation and the method of how to conserve the butterflies of the world.

#6
STUDY ON NUTRITION CONVERSION OF WHEAT BRAN WITH HOUSEFLY (MUSCA DOMESTICA VICINA MACQUART). Liang-bing Zong, Shun-qing Li (Huazhong Agricultural University, Wuhan 430070, China)

By equal analysing of protein and fat in both Larva and wheat bran, authors demonstrated the relation of nutrition conversion between diets and larvae and the influence of the ages and densities on individual and mass of housefly Larvae, the individual with 0.3g eggs/300g diets and the mass outputs with 0.7g eggs/300g diet are the biggest. The optimum efficiency of conversion of wheat bran in various ages and densities of larvae were obtained. They are as follows: the production of protein is from 0.7g eggs/300g diets with larvae of the 2nd age and the production of fat is from 0.5g eggs/300g diets with larvae of 3rd age and from 0.7g eggs/300g diets with 2nd age. The best conversion rate of larvae to the protein of wheat bran from 0.7g eggs/300g diets is 27.54%, and that of the fat from 0.5g eggs/300g diets is high to 42.24%. The average efficiency of conversion of the protein with various densities is 4.11:1, and that of the fat is 2.79:1.

#7

A SEARCH FOR A COMMON PHYSIOLOGICAL BACKGROUND OF THE LIFE-CYCLE DIVERSITY IN INSECTS. V.A.Zaslavski (Zoological Institute, 199034, St.Petersburg, Russia).

Despite the phenomena concerned with the control of insect seasonality are extremely diverse, they could be covered in a unifying model. The main principles this was based on were as follows: quantitative daylength measurement; not joint but consecutive performance of the daylength measurement and the reaction type determination; processing of the photoperiodic information along two different pathways. Independent variation within a limited set of elementary characteristics was shown to produce a wide diversity of photoperiodic and temperature reactions. Physiological and genetic dissection of the life-cycle phenomena would be necessary to comprehend and manipulate the seasonal traits.

#8

ARTIFICIAL REPRODUCTION AND HIGH YIELD TECHNIQUES OF THE CHINESE GALL-NUTS. Xing-hai Peng(Yongshun County Station of Chinese Gall-Nuts Development. Hunan 416700, China)

An advance on the methods of artificial reproduction and the measures of high yield techniques of the Chinese gall nuts are reported. The methods of artificial reproduction must consider following conditions: to select and adaptable fields, to build a forest belt to reproduce and to transplnat the summer host-trees, to widen and to cultivate the winter hosttrees, and to release or to receive the gall-nut aphides by scientific methods. The measures of high-yield techniques must consider following conditions: to protect and to manage the host forest, to build ab adaptable environment where the gall nut aphides live in, to select the fine varieties of host trees, host-moss and a fine aphids population, to apply the integrated measures to release the aphids, to control the natural enemies of gall-nut aphids and to recieve the gall-nuts in adaptable time.

THE STUDIES ON TRACE MINERAL NUTRITION OPTIMUM BALANCE AND THEIR EFFECTS IN HOUSE FLY LARVA. Chang-zhen Zhong, Liang-bing Zong, Jun-yun Zhang(Department of Plant protection,Huazhong Agricultural University, Wuhan 430070, China)

Applied the combinatoral design of squre, regressive and orthogonal rotation, four trace mineral elements, i.e., Iron, Copper, Zine and Manganese, were quantitativelystudied on their effects to house fly larva surviral, growth and development in meridic diets. Built up three squre models about the four trace mineral elements to larva survival percent, weight of 100 larva and larva biomass. Defined the optimum balance of the four trace mineral elements criterion of different larva target. Quantitative or qualitative analysised the signle element effect and interaction between elements to different larva target respectively in the background of optimum balance of trace mineral nutrition. The works function of a signle mineral element is a cluster of parabolic curve with some parameter and its positive and negative effect is a cluster of straight line with some parameter in dynamic state. The interaction of trace mineral nutrition is a cluster of curved surface with some parameter in dynamic state. The result from the paper suggested that the balance of animal mineral nutrition criterion knocked together from the sigle element experiment is not the real optimun balance required from animals.

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